

```

1 C:\Users\Subramanian\AppData\Local\Programs\Python\
  Python39\python.exe C:/Users/Subramanian/IdeaProjects
  /Optimization_using_A_teams_Scenario2/
  main_ateam_parallel_eval_framework.py
2 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.
  77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.
  35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.
  1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89
  ), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
3 [[7, 30, 31, 4], [6, 50, 24, 3], [6, 20, 36, 4], [4,
  12, 21, 2], [2, 13, 40, 3], [4, 6, 50, 2], [5, 15, 31
  , 5], [8, 25, 16, 4], [8, 43, 16, 5], [3, 9, 44, 3
  ], [9, 41, 21, 2], [3, 4, 18, 4], [5, 33, 39, 4], [5
  , 37, 29, 3], [2, 21, 4, 5], [4, 35, 35, 2], [7, 18,
  13, 5], [5, 27, 27, 4], [8, 48, 12, 4], [7, 45, 11, 4
  ], [6, 47, 37, 3], [7, 8, 7, 3], [6, 23, 45, 3], [5,
  16, 2, 3], [4, 19, 43, 4], [7, 32, 9, 5], [8, 40, 6,
  2], [9, 3, 34, 3], [3, 38, 47, 4], [3, 28, 25, 3]]
4 -----
5 UAV optimization via conventional feedforward
  solution
6 -----
7 Start point is: 4
8 Parameters are: 7, 30, 31
9 31
10 16
11 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.
  77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.
  35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.
  1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89
  ), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
12 (5.77, 5.83) (5.35, 6.1)
13 10 10
14 The travel time for UGV from depot B to NW UGV stop
  is: 1568
15 The UGV travel time between two UGV stops is: 1237
16 [(0, 60), (0, 6465), (0, 6465), (0, 6465), (0, 6465
  ), (0, 6465), (0, 6465), (1568, 3368), (1568, 3368
  ), (1568, 3368), (1568, 3368), (1568, 3368), (1568,
  3368), (4605, 6465), (4605, 6465), (4605, 6465), (
  4605, 6465), (4605, 6465), (4605, 6465), (0, 6465), (

```

```
16 0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465)
    ), (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0,
    6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465)]
17 4063356.642395611
18 End node is [24]
19 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15
    , 16, 17, 18, 19, 20, 21, 22, 23]
20 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
    38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50,
    51, 52, 53]
21 Objective: 6003045
22 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 14 15 16 17 18
    19 20 21 22 23 25 26 27 28 29 30
23 54
24 54
25 54
26 54
27 54
28 54
29 54
30 54
31 54
32 54
33 54
34 54
35 54
36 54
37 54
38 54
39 54
40 54
41 54
42 54
43 54
44 54
45 54
```

```
46 54
47 54
48 54
49 Route for vehicle 0:
50 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 53 Fuel(134454) Time(773,833) Slack(0)
  ) FuelSlack(0,0) Distance(25541) -> 52 Fuel(127536)
  Time(807,987) Slack(0) FuelSlack(0,0) Distance(26694
  ) -> 51 Fuel(120925) Time(840,1140) Slack(0)
  FuelSlack(0,0) Distance(27796) -> 50 Fuel(114007)
  Time(874,1294) Slack(0) FuelSlack(0,0) Distance(28949
  ) -> 49 Fuel(107089) Time(908,1448) Slack(0)
  FuelSlack(0,0) Distance(30102) -> 48 Fuel(100478)
  Time(941,1601) Slack(0) FuelSlack(0,0) Distance(31204
  ) -> 47 Fuel(93638) Time(975,1755) Slack(0) FuelSlack
  (0,0) Distance(32344) -> 46 Fuel(86720) Time(1009,
  1909) Slack(0) FuelSlack(0,0) Distance(33497) -> 45
  Fuel(80109) Time(1042,2062) Slack(0) FuelSlack(0,0)
  Distance(34599) -> 44 Fuel(73191) Time(1076,2216)
  Slack(0) FuelSlack(0,0) Distance(35752) -> 43 Fuel(
  66273) Time(1110,2252) Slack(0) FuelSlack(0,0)
  Distance(36905) -> 42 Fuel(59662) Time(1143,2285)
  Slack(0) FuelSlack(0,0) Distance(38007) -> 41 Fuel(
  52744) Time(1261,2319) Slack(0) FuelSlack(0,0)
  Distance(39160) -> 40 Fuel(45826) Time(1415,2353)
  Slack(0) FuelSlack(0,0) Distance(40313) -> 32 Fuel(
  39215) Time(1568,2386) Slack(798) FuelSlack(124902,
  164117) Distance(41415) -> 31 Fuel(162798) Time(2996,
  3814) Slack(0) FuelSlack(0,0) Distance(62232) -> 30
  Fuel(145752) Time(3082,3900) Slack(0) FuelSlack(0,0)
  Distance(65073) -> 33 Fuel(111864) Time(3253,4071)
  Slack(0) FuelSlack(0,0) Distance(70721) -> 34 Fuel(
  95052) Time(3435,4155) Slack(0) FuelSlack(0,0)
  Distance(73523) -> 35 Fuel(78006) Time(3641,4241)
  Slack(0) FuelSlack(0,0) Distance(76364) -> 36 Fuel(
  61170) Time(3846,4326) Slack(0) FuelSlack(0,0)
  Distance(79170) -> 37 Fuel(44358) Time(4050,4410)
  Slack(0) FuelSlack(0,0) Distance(81972) -> 38 Fuel(
  27312) Time(4256,4496) Slack(0) FuelSlack(0,0)
  Distance(84813) -> 39 Fuel(10476) Time(4461,4581)
  Slack(0) FuelSlack(0,0) Distance(87619) -> 13 Fuel(
```



```
71 *
72 UGV route goes infeasible although UAV has a
    solution
73 ****
    **
74 30653910.946875952
75 End node is [18]
76 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17]
77 [19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
    , 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44
    , 45, 46, 47, 48]
78 Objective: 1867
79 Dropped nodes: 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
    17
80 49
81 49
82 49
83 49
84 49
85 49
86 49
87 49
88 49
89 49
90 49
91 49
92 49
93 49
94 49
95 49
96 49
97 49
98 49
99 49
100 49
101 49
102 49
103 49
104 49
105 49
```

```

106 49
107 49
108 49
109 49
110 49
111 49
112 Route for vehicle 0:
113 0 Fuel(287700) Time(3249,3249) Slack(0) FuelSlack(0,
0) Distance(0) -> 33 Fuel(277878) Time(3298,3358)
Slack(0) FuelSlack(0,0) Distance(1637) -> 32 Fuel(
272802) Time(3323,3503) Slack(0) FuelSlack(0,0)
Distance(2483) -> 31 Fuel(267732) Time(3348,3648)
Slack(0) FuelSlack(0,0) Distance(3328) -> 30 Fuel(
262662) Time(3373,3793) Slack(0) FuelSlack(0,0)
Distance(4173) -> 29 Fuel(257586) Time(3398,3938)
Slack(0) FuelSlack(0,0) Distance(5019) -> 28 Fuel(
252834) Time(3422,4082) Slack(0) FuelSlack(0,0)
Distance(5811) -> 27 Fuel(247764) Time(3531,4227)
Slack(0) FuelSlack(0,0) Distance(6656) -> 26 Fuel(
242688) Time(3676,4372) Slack(0) FuelSlack(0,0)
Distance(7502) -> 25 Fuel(237618) Time(3821,4517)
Slack(0) FuelSlack(0,0) Distance(8347) -> 24 Fuel(
232548) Time(3966,4662) Slack(0) FuelSlack(0,0)
Distance(9192) -> 23 Fuel(227472) Time(4111,4807)
Slack(0) FuelSlack(0,0) Distance(10038) -> 22 Fuel(
222402) Time(4256,4952) Slack(0) FuelSlack(0,0)
Distance(10883) -> 21 Fuel(217650) Time(4400,5096)
Slack(0) FuelSlack(0,0) Distance(11675) -> 20 Fuel(
212574) Time(4545,5241) Slack(0) FuelSlack(0,0)
Distance(12521) -> 19 Fuel(207504) Time(4690,5386)
Slack(0) FuelSlack(0,0) Distance(13366) -> 1 Fuel(
125040) Time(5226,5922) Slack(523) FuelSlack(54438,
179478) Distance(27110) -> 41 Fuel(233262) Time(6425
,7121) Slack(0) FuelSlack(0,0) Distance(36183) -> 42
Fuel(226344) Time(6579,7275) Slack(0) FuelSlack(0,0
) Distance(37336) -> 44 Fuel(212898) Time(6766,7462
) Slack(0) FuelSlack(0,0) Distance(39577) -> 45 Fuel(
205980) Time(6920,7616) Slack(0) FuelSlack(0,0)
Distance(40730) -> 46 Fuel(199062) Time(7074,7770)
Slack(0) FuelSlack(0,0) Distance(41883) -> 47 Fuel(
192451) Time(7227,7923) Slack(0) FuelSlack(0,0)

```

```
113 Distance(42985) -> 48 Fuel(185533) Time(7381,8077)
    Slack(0) FuelSlack(0,0) Distance(44138) -> 43 Fuel(
    151549) Time(7672,8368) Slack(0) FuelSlack(0,0)
    Distance(49802) -> 40 Fuel(131185) Time(7894,8590)
    Slack(0) FuelSlack(0,0) Distance(53196) -> 39 Fuel(
    124267) Time(8048,8744) Slack(0) FuelSlack(0,0)
    Distance(54349) -> 38 Fuel(117349) Time(8202,8802)
    Slack(0) FuelSlack(0,0) Distance(55502) -> 37 Fuel(
    110738) Time(8355,8835) Slack(0) FuelSlack(0,0)
    Distance(56604) -> 36 Fuel(103820) Time(8509,8869)
    Slack(0) FuelSlack(0,0) Distance(57757) -> 35 Fuel(
    96902) Time(8663,8903) Slack(0) FuelSlack(0,0)
    Distance(58910) -> 34 Fuel(90291) Time(8816,8936)
    Slack(0) FuelSlack(0,0) Distance(60012) -> 18 Fuel(
    76455) Time(9005,9005) Distance(62318)
114 Distance of the route: 62318 ft
115 Remaining Fuel of the route: 76455
116 Total Time of the route: 9005 seconds
117
118 Total Distance of all routes: 62318 ft
119 Total Fuel remaining of all routes: 76455
120 Total Time of all routes: 9005 seconds
121 -----
122 UAV optimization via conventional feedforward
    solution
123 -----
124 Start point is: 4
125 Parameters are: 6, 20, 36
126 31
127 16
128 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
    .77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
    .35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
    6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
    89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
129 (5.56, 5.89) (5.35, 6.1)
130 10 10
131 The travel time for UGV from depot B to NW UGV stop
    is: 1452
132 The UGV travel time between two UGV stops is: 1121
133 [(0, 60), (0, 5933), (0, 5933), (0, 5933), (0, 5933)
```



```
155 16
156 16
157 (5.35, 6.26) (5.56, 5.89)
158 10 10
159 The travel time for UGV from depot B to NW UGV stop
is: 4387
160 The UGV travel time between two UGV stops is: 1205
161 [(0, 60), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (4387, 5107), (4387
, 5107), (4387, 5107), (4387, 5107), (4387, 5107),
(4387, 5107), (6312, 7572), (6312, 7572), (6312, 7572
), (6312, 7572), (6312, 7572), (6312, 7572), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912), (0, 11912), (0,
11912), (0, 11912), (0, 11912)]
162 16363109.058762573
163 End node is [24]
164 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
165 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
, 51, 52, 53]
166 Objective: 29000000
167 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53
168 54
169 Route for vehicle 0:
170 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
Distance(0) -> 24 Fuel(287700) Time(0,0) Distance(0)
171 Distance of the route: 0 ft
172 Remaining Fuel of the route: 287700
173 Total Time of the route: 0 seconds
174
```

```
175 Total Distance of all routes: 0 ft
176 Total Fuel remaining of all routes: 287700
177 Total Time of all routes: 0 seconds
178 -----
179 UAV optimization via conventional feedforward
    solution
180 -----
181 Start point is: 3
182 Parameters are: 2, 13, 40
183 16
184 16
185 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
    .77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
    .35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
    6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
    89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
186 (5.35, 6.1) (5.56, 5.89)
187 10 10
188 The travel time for UGV from depot B to NW UGV stop
    is: 3328
189 The UGV travel time between two UGV stops is: 1121
190 [(3249, 3309), (3328, 4108), (3328, 4108), (3328,
    4108), (3328, 4108), (3328, 4108), (3328, 4108), (
    5229, 7629), (5229, 7629), (5229, 7629), (5229, 7629
    ), (5229, 7629), (5229, 7629), (0, 15218), (0, 15218
    ), (0, 15218), (0, 15218), (0, 15218), (7745, 15218
    ), (0, 15218), (0, 15218), (0, 15218), (0, 15218), (
    0, 15218), (0, 15218), (0, 15218), (0, 15218), (0,
    15218), (0, 15218), (0, 15218), (0, 15218), (0,
    15218), (0, 15218), (0, 15218), (0, 15218), (0,
    15218), (0, 15218), (0, 15218), (0, 15218), (0,
    15218), (0, 15218)]
191 ****
**  

192 UGV route goes infeasible although UAV has a
    solution
193 ****
**  

194 28102406.122401707
```

```
195 End node is [18]
196 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
   15, 16, 17]
197 [19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
   , 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44
   , 45, 46, 47, 48]
198 Objective: 1866
199 Dropped nodes: 1 2 3 4 5 6 7 10 11 12 13 14 15 16 17
200 49
201 49
202 49
203 49
204 49
205 49
206 49
207 49
208 49
209 49
210 49
211 49
212 49
213 49
214 49
215 49
216 49
217 49
218 49
219 49
220 49
221 49
222 49
223 49
224 49
225 49
226 49
227 49
228 49
229 49
230 49
231 49
232 49
```

```

233 Route for vehicle 0:
234 0 Fuel(287700) Time(3249,3249) Slack(0) FuelSlack(0,
0) Distance(0) -> 33 Fuel(277878) Time(3298,3358)
Slack(0) FuelSlack(0,0) Distance(1637) -> 32 Fuel(
272802) Time(3323,3503) Slack(0) FuelSlack(0,0)
Distance(2483) -> 31 Fuel(267732) Time(3348,3648)
Slack(0) FuelSlack(0,0) Distance(3328) -> 30 Fuel(
262662) Time(3373,3793) Slack(0) FuelSlack(0,0)
Distance(4173) -> 29 Fuel(257586) Time(3398,3938)
Slack(0) FuelSlack(0,0) Distance(5019) -> 28 Fuel(
252834) Time(3422,4082) Slack(0) FuelSlack(0,0)
Distance(5811) -> 27 Fuel(247764) Time(3534,4227)
Slack(0) FuelSlack(0,0) Distance(6656) -> 26 Fuel(
242688) Time(3679,4372) Slack(0) FuelSlack(0,0)
Distance(7502) -> 25 Fuel(237618) Time(3824,4517)
Slack(0) FuelSlack(0,0) Distance(8347) -> 24 Fuel(
232548) Time(3969,4662) Slack(0) FuelSlack(0,0)
Distance(9192) -> 23 Fuel(227472) Time(4114,4807)
Slack(0) FuelSlack(0,0) Distance(10038) -> 19 Fuel(
207510) Time(4334,5027) Slack(0) FuelSlack(0,0)
Distance(13365) -> 20 Fuel(202440) Time(4479,5122)
Slack(0) FuelSlack(0,0) Distance(14210) -> 21 Fuel(
197364) Time(4624,5147) Slack(0) FuelSlack(0,0)
Distance(15056) -> 22 Fuel(192612) Time(4768,5171)
Slack(0) FuelSlack(0,0) Distance(15848) -> 8 Fuel(
124986) Time(5229,5512) Slack(523) FuelSlack(43642,
131904) Distance(27119) -> 34 Fuel(280782) Time(5786
,6069) Slack(0) FuelSlack(0,0) Distance(28272) -> 35
Fuel(274171) Time(5819,6102) Slack(0) FuelSlack(0,0
) Distance(29374) -> 36 Fuel(267253) Time(5853,6136
) Slack(0) FuelSlack(0,0) Distance(30527) -> 37 Fuel(
260335) Time(5887,6170) Slack(0) FuelSlack(0,0)
Distance(31680) -> 38 Fuel(253724) Time(5920,6203)
Slack(0) FuelSlack(0,0) Distance(32782) -> 39 Fuel(
246806) Time(5954,6237) Slack(0) FuelSlack(0,0)
Distance(33935) -> 40 Fuel(239888) Time(5988,6271)
Slack(0) FuelSlack(0,0) Distance(35088) -> 43 Fuel(
219524) Time(6090,6373) Slack(0) FuelSlack(0,0)
Distance(38482) -> 48 Fuel(185540) Time(6261,6544)
Slack(0) FuelSlack(0,0) Distance(44146) -> 47 Fuel(
178622) Time(6295,6578) Slack(0) FuelSlack(0,0)

```



```
253 13292), (0, 13292), (0, 13292), (0, 13292), (0,
    13292), (0, 13292), (0, 13292), (0, 13292), (0,
    13292), (0, 13292), (0, 13292), (0, 13292), (0,
    13292), (0, 13292), (0, 13292)]
254 16639109.058762573
255 End node is [24]
256 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
257 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]
258 Objective: 290000000
259 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33
    34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
    51 52 53
260 54
261 Route for vehicle 0:
262 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 24 Fuel(287700) Time(0,0) Distance(0)
263 Distance of the route: 0 ft
264 Remaining Fuel of the route: 287700
265 Total Time of the route: 0 seconds
266
267 Total Distance of all routes: 0 ft
268 Total Fuel remaining of all routes: 287700
269 Total Time of all routes: 0 seconds
270 -----
271 UAV optimization via conventional feedforward
    solution
272 -----
273 Start point is: 5
274 Parameters are: 5, 15, 31
275 16
276 31
277 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
    .77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
    .35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
    6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
    89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
278 (5.35, 6.26) (5.77, 5.83)
```

```
279 10 10
280 The travel time for UGV from depot B to NW UGV stop
is: 1980
281 The UGV travel time between two UGV stops is: 1322
282 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (1980, 2880), (1980, 2880),
     (1980, 2880), (1980, 2880), (1980, 2880), (1980,
     2880), (4202, 6062), (4202, 6062), (4202, 6062), (
     4202, 6062), (4202, 6062), (4202, 6062), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651)]
283 7581712.12724779
284 End node is [24]
285 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
286 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]
287 Objective: 4044
288 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
289 54
290 54
291 54
292 54
293 54
294 54
295 54
296 54
297 54
298 54
299 54
300 54
301 54
302 54
```

```
303 54
304 54
305 54
306 54
307 54
308 54
309 54
310 54
311 54
312 54
313 54
314 54
315 54
316 54
317 54
318 54
319 54
320 54
321 Route for vehicle 0:
322 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
    ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
    Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
    ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
```

```

322 36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
Slack(846) FuelSlack(24408,287700) Distance(81152
) -> 24 Fuel(287700) Time(6468,6468) Distance(133951
)

323 Distance of the route: 133951 ft
324 Remaining Fuel of the route: 287700
325 Total Time of the route: 6468 seconds
326
327 Total Distance of all routes: 133951 ft
328 Total Fuel remaining of all routes: 287700
329 Total Time of all routes: 6468 seconds
330 -----
-----  

331 *****UAV optimization via feedback
solution*****
332 -----
-----
```

```
333 Start point is: 5
334 Parameters are: 5, 15, 31
335 16
336 31
337 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
338 (5.35, 6.26) (5.77, 5.83)
339 10 10
340 The travel time for UGV from depot B to NW UGV stop
is: 1980
341 The UGV travel time between two UGV stops is: 1322
342 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651
), (0, 7651), (0, 7651), (1980, 2880), (1980, 2880
), (1980, 2880), (1980, 2880), (1980, 2880), (1980,
2880), (4202, 6062), (4202, 6062), (4202, 6062), (
4202, 6062), (4202, 6062), (4202, 6062), (0, 7651
), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651)]
343 7581712.12724779
344 End node is [24]
345 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
346 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
, 51, 52, 53]
347 Objective: 2445
348 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22
349 54
350 54
351 54
352 54
```

```
353 54
354 54
355 54
356 54
357 54
358 54
359 54
360 54
361 54
362 54
363 54
364 54
365 54
366 54
367 54
368 54
369 54
370 54
371 54
372 54
373 54
374 54
375 54
376 54
377 54
378 54
379 54
380 54
381 Route for vehicle 0:
382 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
    ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
    Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
    ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
```

```

382 Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
    FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152)
383 Distance of the route: 81152 ft
384 Remaining Fuel of the route: 287700
385 Total Time of the route: 4869 seconds
386

```

```
387 Total Distance of all routes: 81152 ft
388 Total Fuel remaining of all routes: 287700
389 Total Time of all routes: 4869 seconds
390 -----
391 ****UAV optimization via feedback
392 solution*****
393 -----
394 Start point is: 5.0
395 Parameters are: 5.0, 15.0, 31.0
396 16
397 31
398 Candidate 1: [5, 15, 31, 5, 1183]
399 Candidate 2: [2, 13, 40, 3, 5007473]
400 Candidate 1: [6, 50, 24, 3, 5007473]
401 Candidate 2: [7, 30, 31, 4, 6003045]
402 Father before deletion: [5, 15, 31, 5, 1183]
403 Mother before deletion: [6, 50, 24, 3, 5007473]
404 Father after deletion: [5, 15, 31, 5]
405 Mother after deletion: [6, 50, 24, 3]
406 00000101000011110001111100000101
407 0000011000110010000110000000011
408 Offspring1 after mutation:
409 0000011000110010000110000000010
410 Offspring2 after mutation:
411 00000101000011110001111100000101
412 32 32
413 [6, 50, 24, 2]
414 [5, 15, 31, 5]
415 -----
416 UAV optimization via conventional feedforward
417 solution
418 -----
419 Start point is: 5
420 Parameters are: 5, 15, 31
421 16
422 31
423 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
424 .77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
425 .35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
```

```

419 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
420 (5.35, 6.26) (5.77, 5.83)
421 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.
77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.
35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
10 10
422 The travel time for UGV from depot B to NW UGV stop
is: 1980
423 The UGV travel time between two UGV stops is: 1322
424 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651), (1980, 2880), (1980, 2880),
(1980, 2880), (1980, 2880), (1980, 2880), (1980,
2880), (4202, 6062), (4202, 6062), (4202, 6062), (
4202, 6062), (4202, 6062), (4202, 6062), (0, 7651),
(0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651)]
425 7581712.12724779
426 End node is [24]
427 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
428 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
, 51, 52, 53]
429
430 (5.35, 6.26) (5.77, 5.83)
431 10 10
432 The travel time for UGV from depot B to NW UGV stop
is: 1980
433 The UGV travel time between two UGV stops is: 1322
434 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
(0, 7651), (0, 7651), (1980, 2880), (1980, 2880),
(1980, 2880), (1980, 2880), (1980, 2880), (1980,
2880)]

```

```
434 2880), (4202, 6062), (4202, 6062), (4202, 6062), (0, 7651),
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651)]]
435 7581712.12724779
436 End node is [24]
437 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
438 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]
439 Objective: 4044
440 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
441 54
442 54
443 54
444 54
445 54
446 54
447 54
448 54
449 54
450 54
451 54
452 54
453 54
454 54
455 54
456 54
457 54
458 54
459 54
460 54
461 54
```

```
462 54
463 54
464 54
465 54
466 54
467 54
468 54
469 54
470 Objective: 2445
471 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
472 54
473 54
474 5454
475 54
476 54
477 Route for vehicle 0:
478 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
    ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
    Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
    ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
    FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
```

```

478 277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(6468,6468) Distance(133951
    )
479 Distance of the route: 133951 ft
480 Remaining Fuel of the route: 287700
481 Total Time of the route: 6468 seconds
482
483 Total Distance of all routes: 133951 ft
484 Total Fuel remaining of all routes: 287700
485 Total Time of all routes: 6468 seconds
486
487 54
488 54
489 54
490 54
491 ***** Execute updated global
        optimization*****
492 -----

```

```
492 -----
493 *****UAV optimization via feedback
      solution*****
494 -----
495 Start point is: 5
496 Parameters are: 5, 15, 31
497 16
498 31
499 54
500 54
501 54
502 54
503 54
504 54
505 54
506 54
507 54
508 54
509 54
510 54
511 54
512 54
513 54
514 54
515 54
516 54
517 54
518 54
519 54
520 54
521 54
522 54
523 54
524 Route for vehicle 0:
525 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
      ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
      Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
      ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
      FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
```

```

525 Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)

```



```
562 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
      17 18 19 20 21 22  
563 54  
564 54  
565 54  
566 54  
567 54  
568 54  
569 54  
570 54  
571 54  
572 54  
573 54  
574 54  
575 54  
576 54  
577 54  
578 54  
579 54  
580 54  
581 54  
582 54  
583 54  
584 54  
585 54  
586 54  
587 54  
588 54  
589 54  
590 54  
591 54  
592 54  
593 54  
594 54  
595 Route for vehicle 0:  
596 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)  
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)  
    ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)  
    Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386  
    ) -> 27 Fuel(124308) Time(823,1123) Slack(0)  
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
```

```

596 Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)

```

```
596 Slack(846) FuelSlack(24408,287700) Distance(81152
      ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152)
597 Distance of the route: 81152 ft
598 Remaining Fuel of the route: 287700
599 Total Time of the route: 4869 seconds
600
601 Total Distance of all routes: 81152 ft
602 Total Fuel remaining of all routes: 287700
603 Total Time of all routes: 4869 seconds
604 Global population dict is: {(5, 15, 31, 5): 2782}
605 -----
606 UAV optimization via conventional feedforward
      solution
607 -----
608 Start point is: 3
609 Parameters are: 6, 50, 24
610 16
611 16
612 Objective: 2445
613 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
      17 18 19 20 21 22
614 54
615 54
616 54
617 54
618 54
619 54
620 54
621 54
622 54
623 54
624 54
625 54
626 54
627 54
628 54
629 54
630 54
631 54
632 54
633 54
```

```
634 54
635 54
636 54
637 54
638 54
639 54
640 54
641 54
642 54
643 54
644 54
645 54
646 Route for vehicle 0:
647 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
  ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
  Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
  ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
  FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
  Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
  28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
  FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
  Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
  29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
  FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
  Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
  31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
  FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
  Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
  33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
  FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
  Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
  34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
  FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
  Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
  36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
  FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
  277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
  Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
  Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
  243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
```

```

647 Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152)
648 Distance of the route: 81152 ft
649 Remaining Fuel of the route: 287700
650 Total Time of the route: 4869 seconds
651
652 Total Distance of all routes: 81152 ft
653 Total Fuel remaining of all routes: 287700
654 Total Time of all routes: 4869 seconds
655 Objective value is: 2782
656 -----
-----  

657 *****UAV optimization via feedback
solution*****
658 -----
-----  

659 Start point is: 5.0
660 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}

```

```
661 (5.56, 5.89) (5.35, 6.1)
662 10 10
663 The travel time for UGV from depot B to NW UGV stop
is: 3365
664 Parameters are: 5.0, 15.75, 31.0The UGV travel time
between two UGV stops is: 1121
665 [(3249, 3309), (3365, 6365), (3365, 6365), (3365,
6365), (3365, 6365), (3365, 6365), (3365, 6365), (
7486, 8926), (7486, 8926), (7486, 8926), (7486, 8926
), (7486, 8926), (7486, 8926), (0, 16478), (0, 16478
), (0, 16478), (0, 16478), (0, 16478), (9005, 16478
), (0, 16478), (0, 16478), (0, 16478), (0, 16478), (0
, 16478), (0, 16478), (0, 16478), (0, 16478), (0,
16478), (0, 16478), (0, 16478), (0, 16478), (0,
16478), (0, 16478), (0, 16478), (0, 16478), (0,
16478), (0, 16478), (0, 16478), (0, 16478), (0,
16478), (0, 16478), (0, 16478), (0, 16478)]
666 ****
**
667 UGV route goes infeasible although UAV has a
solution
668 ****
**
669 30653910.946875952
670 End node is [18]
671
672 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17]
673 [19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44
, 45, 46, 47, 48]
674 16
675 31
676 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
677 (5.35, 6.26) (5.77, 5.83)
```

```
678 10 10
679 The travel time for UGV from depot B to NW UGV stop
is: 1980
680 The UGV travel time between two UGV stops is: 1322
681 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (1980, 2880), (1980, 2880),
     (1980, 2880), (1980, 2880), (1980, 2880), (1980,
     2880), (4202, 6062), (4202, 6062), (4202, 6062), (
     4202, 6062), (4202, 6062), (4202, 6062), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     (0, 7651), (0, 7651)]
682 7581712.12724779
683 End node is [24]
684 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
685 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]
686 Objective: 1867
687 Dropped nodes: 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
    17
688 49
689 49
690 49
691 49
692 49
693 49
694 49
695 49
696 49
697 49
698 49
699 49
700 49
701 49
```

```
702 49
703 49
704 49
705 49
706 49
707 49
708 49
709 49
710 49
711 49
712 49
713 49
714 49
715 49
716 49
717 49
718 49
719 49
720 Route for vehicle 0:
721 0 Fuel(287700) Time(3249,3249) Slack(0) FuelSlack(0,
    0) Distance(0) -> 33 Fuel(277878) Time(3298,3358)
    Slack(0) FuelSlack(0,0) Distance(1637) -> 32 Fuel(
        272802) Time(3323,3503) Slack(0) FuelSlack(0,0)
        Distance(2483) -> 31 Fuel(267732) Time(3348,3648)
        Slack(0) FuelSlack(0,0) Distance(3328) -> 30 Fuel(
            262662) Time(3373,3793) Slack(0) FuelSlack(0,0)
            Distance(4173) -> 29 Fuel(257586) Time(3398,3938)
            Slack(0) FuelSlack(0,0) Distance(5019) -> 28 Fuel(
                252834) Time(3422,4082) Slack(0) FuelSlack(0,0)
                Distance(5811) -> 27 Fuel(247764) Time(3531,4227)
                Slack(0) FuelSlack(0,0) Distance(6656) -> 26 Fuel(
                    242688) Time(3676,4372) Slack(0) FuelSlack(0,0)
                    Distance(7502) -> 25 Fuel(237618) Time(3821,4517)
                    Slack(0) FuelSlack(0,0) Distance(8347) -> 24 Fuel(
                        232548) Time(3966,4662) Slack(0) FuelSlack(0,0)
                        Distance(9192) -> 23 Fuel(227472) Time(4111,4807)
                        Slack(0) FuelSlack(0,0) Distance(10038) -> 22 Fuel(
                            222402) Time(4256,4952) Slack(0) FuelSlack(0,0)
                            Distance(10883) -> 21 Fuel(217650) Time(4400,5096)
                            Slack(0) FuelSlack(0,0) Distance(11675) -> 20 Fuel(
                                212574) Time(4545,5241) Slack(0) FuelSlack(0,0)
```

```

721 Distance(12521) -> 19 Fuel(207504) Time(4690,5386)
    Slack(0) FuelSlack(0,0) Distance(13366) -> 1 Fuel(
    125040) Time(5226,5922) Slack(523) FuelSlack(54438,
    179478) Distance(27110) -> 41 Fuel(233262) Time(6425
    ,7121) Slack(0) FuelSlack(0,0) Distance(36183) -> 42
    Fuel(226344) Time(6579,7275) Slack(0) FuelSlack(0,0
    ) Distance(37336) -> 44 Fuel(212898) Time(6766,7462
    ) Slack(0) FuelSlack(0,0) Distance(39577) -> 45 Fuel(
    205980) Time(6920,7616) Slack(0) FuelSlack(0,0)
    Distance(40730) -> 46 Fuel(199062) Time(7074,7770)
    Slack(0) FuelSlack(0,0) Distance(41883) -> 47 Fuel(
    192451) Time(7227,7923) Slack(0) FuelSlack(0,0)
    Distance(42985) -> 48 Fuel(185533) Time(7381,8077)
    Slack(0) FuelSlack(0,0) Distance(44138) -> 43 Fuel(
    151549) Time(7672,8368) Slack(0) FuelSlack(0,0)
    Distance(49802) -> 40 Fuel(131185) Time(7894,8590)
    Slack(0) FuelSlack(0,0) Distance(53196) -> 39 Fuel(
    124267) Time(8048,8744) Slack(0) FuelSlack(0,0)
    Distance(54349) -> 38 Fuel(117349) Time(8202,8802)
    Slack(0) FuelSlack(0,0) Distance(55502) -> 37 Fuel(
    110738) Time(8355,8835) Slack(0) FuelSlack(0,0)
    Distance(56604) -> 36 Fuel(103820) Time(8509,8869)
    Slack(0) FuelSlack(0,0) Distance(57757) -> 35 Fuel(
    96902) Time(8663,8903) Slack(0) FuelSlack(0,0)
    Distance(58910) -> 34 Fuel(90291) Time(8816,8936)
    Slack(0) FuelSlack(0,0) Distance(60012) -> 18 Fuel(
    76455) Time(9005,9005) Distance(62318)

722 Distance of the route: 62318 ft
723 Remaining Fuel of the route: 76455
724 Total Time of the route: 9005 seconds
725
726 Total Distance of all routes: 62318 ft
727 Total Fuel remaining of all routes: 76455
728 Total Time of all routes: 9005 seconds
729 Global population dict is: {(5, 15, 31, 5): 2782, (6
    , 50, 24, 3): 7473}
730 -----
731 UAV optimization via conventional feedforward
    solution
732 -----
733 Start point is: 3

```

```

734 Parameters are: 2, 13, 40
735 16
736 16
737 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
738 (5.35, 6.1) (5.56, 5.89)
739 10 10
740 The travel time for UGV from depot B to NW UGV stop
is: 3328
741 The UGV travel time between two UGV stops is: 1121
742 [(3249, 3309), (3328, 4108), (3328, 4108), (3328,
4108), (3328, 4108), (3328, 4108), (3328, 4108), (
5229, 7629), (5229, 7629), (5229, 7629), (5229, 7629
), (5229, 7629), (5229, 7629), (0, 15218), (0, 15218
), (0, 15218), (0, 15218), (0, 15218), (7745, 15218
), (0, 15218), (0, 15218), (0, 15218), (0, 15218), (
0, 15218), (0, 15218), (0, 15218), (0, 15218), (0,
15218), (0, 15218), (0, 15218), (0, 15218), (0,
15218), (0, 15218), (0, 15218), (0, 15218), (0,
15218), (0, 15218), (0, 15218), (0, 15218), (0,
15218), (0, 15218), (0, 15218)]
743 ****
**
744 UGV route goes infeasible although UAV has a
solution
745 ****
**
746 28102406.122401707
747 End node is [18]
748 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17]
749 [19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44
, 45, 46, 47, 48]
750 Objective: 2445
751 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16

```

```
751 17 18 19 20 21 22
752 54
753 54
754 54
755 54
756 54
757 54
758 54
759 54
760 54
761 54
762 54
763 54
764 54
765 54
766 54
767 54
768 54
769 54
770 54
771 54
772 54
773 54
774 54
775 54
776 54
777 54
778 54
779 54
780 54
781 54
782 54
783 54
784 Route for vehicle 0:
785 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0
    ) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
    Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386
    ) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
```

```

785 28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
Slack(846) FuelSlack(24408,287700) Distance(81152)

```



```
806 7711), (0, 7711)]  
807 7593712.12724779  
808 End node is [24]  
809 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
810 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50  
    , 51, 52, 53]  
811 Objective: 1866  
812 Dropped nodes: 1 2 3 4 5 6 7 10 11 12 13 14 15 16 17  
813 49  
814 49  
815 49  
816 49  
817 49  
818 49  
819 49  
820 49  
821 49  
822 49  
823 49  
824 49  
825 49  
826 49  
827 49  
828 49  
829 49  
830 49  
831 49  
832 49  
833 49  
834 49  
835 49  
836 49  
837 49  
838 49  
839 49  
840 49  
841 49  
842 49  
843 49
```

```

844 49
845 49
846 Route for vehicle 0:
847 0 Fuel(287700) Time(3249,3249) Slack(0) FuelSlack(0,
0) Distance(0) -> 33 Fuel(277878) Time(3298,3358)
Slack(0) FuelSlack(0,0) Distance(1637) -> 32 Fuel(
272802) Time(3323,3503) Slack(0) FuelSlack(0,0)
Distance(2483) -> 31 Fuel(267732) Time(3348,3648)
Slack(0) FuelSlack(0,0) Distance(3328) -> 30 Fuel(
262662) Time(3373,3793) Slack(0) FuelSlack(0,0)
Distance(4173) -> 29 Fuel(257586) Time(3398,3938)
Slack(0) FuelSlack(0,0) Distance(5019) -> 28 Fuel(
252834) Time(3422,4082) Slack(0) FuelSlack(0,0)
Distance(5811) -> 27 Fuel(247764) Time(3534,4227)
Slack(0) FuelSlack(0,0) Distance(6656) -> 26 Fuel(
242688) Time(3679,4372) Slack(0) FuelSlack(0,0)
Distance(7502) -> 25 Fuel(237618) Time(3824,4517)
Slack(0) FuelSlack(0,0) Distance(8347) -> 24 Fuel(
232548) Time(3969,4662) Slack(0) FuelSlack(0,0)
Distance(9192) -> 23 Fuel(227472) Time(4114,4807)
Slack(0) FuelSlack(0,0) Distance(10038) -> 19 Fuel(
207510) Time(4334,5027) Slack(0) FuelSlack(0,0)
Distance(13365) -> 20 Fuel(202440) Time(4479,5122)
Slack(0) FuelSlack(0,0) Distance(14210) -> 21 Fuel(
197364) Time(4624,5147) Slack(0) FuelSlack(0,0)
Distance(15056) -> 22 Fuel(192612) Time(4768,5171)
Slack(0) FuelSlack(0,0) Distance(15848) -> 8 Fuel(
124986) Time(5229,5512) Slack(523) FuelSlack(43642,
131904) Distance(27119) -> 34 Fuel(280782) Time(5786
,6069) Slack(0) FuelSlack(0,0) Distance(28272) -> 35
Fuel(274171) Time(5819,6102) Slack(0) FuelSlack(0,0
) Distance(29374) -> 36 Fuel(267253) Time(5853,6136
) Slack(0) FuelSlack(0,0) Distance(30527) -> 37 Fuel(
260335) Time(5887,6170) Slack(0) FuelSlack(0,0)
Distance(31680) -> 38 Fuel(253724) Time(5920,6203)
Slack(0) FuelSlack(0,0) Distance(32782) -> 39 Fuel(
246806) Time(5954,6237) Slack(0) FuelSlack(0,0)
Distance(33935) -> 40 Fuel(239888) Time(5988,6271)
Slack(0) FuelSlack(0,0) Distance(35088) -> 43 Fuel(
219524) Time(6090,6373) Slack(0) FuelSlack(0,0)
Distance(38482) -> 48 Fuel(185540) Time(6261,6544)

```

```

847 Slack(0) FuelSlack(0,0) Distance(44146) -> 47 Fuel(
178622) Time(6295,6578) Slack(0) FuelSlack(0,0)
Distance(45299) -> 46 Fuel(172011) Time(6328,6611)
Slack(0) FuelSlack(0,0) Distance(46401) -> 45 Fuel(
165093) Time(6362,6645) Slack(0) FuelSlack(0,0)
Distance(47554) -> 44 Fuel(158175) Time(6396,6679)
Slack(0) FuelSlack(0,0) Distance(48707) -> 42 Fuel(
144729) Time(6506,6746) Slack(0) FuelSlack(0,0)
Distance(50948) -> 41 Fuel(137811) Time(6660,6780)
Slack(0) FuelSlack(0,0) Distance(52101) -> 9 Fuel(
83373) Time(7054,7054) Slack(657) FuelSlack(83373,
287700) Distance(61174) -> 18 Fuel(287700) Time(7745
,7745) Distance(62327)
848 Distance of the route: 62327 ft
849 Remaining Fuel of the route: 287700
850 Total Time of the route: 7745 seconds
851
852 Total Distance of all routes: 62327 ft
853 Total Fuel remaining of all routes: 287700
854 Total Time of all routes: 7745 seconds
855 Global population dict is: {(5, 15, 31, 5): 2782, (6
, 50, 24, 3): 7473, (2, 13, 40, 3): 7473}
856 -----
857 UAV optimization via conventional feedforward
solution
858 -----
859 Start point is: 4
860 Parameters are: 7, 30, 31
861 31
862 16
863 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5
.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
864 (5.77, 5.83) (5.35, 6.1)
865 10 10
866 The travel time for UGV from depot B to NW UGV stop
is: 1568
867 The UGV travel time between two UGV stops is: 1237
868 [(0, 60), (0, 6465), (0, 6465), (0, 6465), (0, 6465]

```

```
868 ), (0, 6465), (0, 6465), (1568, 3368), (1568, 3368)
    ), (1568, 3368), (1568, 3368), (1568, 3368), (1568,
    3368), (4605, 6465), (4605, 6465), (4605, 6465), (
    4605, 6465), (4605, 6465), (4605, 6465), (0, 6465
    ), (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0,
    6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465
    ), (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0,
    6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465),
    (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465
    ), (0, 6465), (0, 6465), (0, 6465), (0, 6465), (0,
    6465), (0, 6465), (0, 6465), (0, 6465), (0, 6465
    ), (0, 6465), (0, 6465)]  
869 4063356.642395611  
870 End node is [24]Objective: 2445  
871 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22  
872  
873 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
874 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]  
875 54  
876 54  
877 54  
878 54  
879 54  
880 54  
881 54  
882 54  
883 54  
884 54  
885 54  
886 54  
887 54  
888 54  
889 54  
890 54  
891 54  
892 54  
893 54
```

```
894 54
895 54
896 54
897 54
898 54
899 54
900 54
901 54
902 54
903 54
904 54
905 54
906 54
907 Route for vehicle 0:
908 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
    FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
      Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386)
        -> 27 Fuel(124308) Time(823,1123) Slack(0)
          FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
            Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
              28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
                FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
                  Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
                    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
                      FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
                        Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
                          31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
                            FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
                              Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
                                33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
                                  FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
                                    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
                                      34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
                                        FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
                                          Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
                                            36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
                                              FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
                                                277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
                                                Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
                                                  Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
```

```

908 243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152)
909 Distance of the route: 81152 ft
910 Remaining Fuel of the route: 287700
911 Total Time of the route: 4869 seconds
912
913 Total Distance of all routes: 81152 ft
914 Total Fuel remaining of all routes: 287700
915 Total Time of all routes: 4869 seconds
916 Objective value is: 2842
917 -----
-----  

918 *****UAV optimization via feedback
    solution*****
919 -----
-----  

920 Start point is: 5.25
921 Parameters are: 5.0, 15.0, 31.0
922 16
923 31
924 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5

```

```
924 .77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5
    .35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35,
    6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.
    89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
925 (5.35, 6.26) (5.77, 5.83)
926 10 10
927 The travel time for UGV from depot B to NW UGV stop
    is: 1980
928 The UGV travel time between two UGV stops is: 1322
929 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651), (1980, 2880), (1980, 2880
    ), (1980, 2880), (1980, 2880), (1980, 2880), (1980,
    2880), (4202, 6062), (4202, 6062), (4202, 6062), (
    4202, 6062), (4202, 6062), (4202, 6062), (0, 7651
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651)]
930 7581712.12724779
931 End node is [24]
932 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
933 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50
    , 51, 52, 53]
934 Objective: 6003045
935 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 14 15 16 17
    18 19 20 21 22 23 25 26 27 28 29 30
936 54
937 54
938 54
939 54
940 54
941 54
942 54
943 54
944 54
```

```
945 54
946 54
947 54
948 54
949 54
950 54
951 54
952 54
953 54
954 54
955 54
956 54
957 54
958 54
959 54
960 54
961 54
962 Route for vehicle 0:
963 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 53 Fuel(134454) Time(773,833) Slack(0)
    ) FuelSlack(0,0) Distance(25541) -> 52 Fuel(127536)
    Time(807,987) Slack(0) FuelSlack(0,0) Distance(26694
    ) -> 51 Fuel(120925) Time(840,1140) Slack(0)
    FuelSlack(0,0) Distance(27796) -> 50 Fuel(114007)
    Time(874,1294) Slack(0) FuelSlack(0,0) Distance(
    28949) -> 49 Fuel(107089) Time(908,1448) Slack(0)
    FuelSlack(0,0) Distance(30102) -> 48 Fuel(100478)
    Time(941,1601) Slack(0) FuelSlack(0,0) Distance(
    31204) -> 47 Fuel(93638) Time(975,1755) Slack(0)
    FuelSlack(0,0) Distance(32344) -> 46 Fuel(86720)
    Time(1009,1909) Slack(0) FuelSlack(0,0) Distance(
    33497) -> 45 Fuel(80109) Time(1042,2062) Slack(0)
    FuelSlack(0,0) Distance(34599) -> 44 Fuel(73191)
    Time(1076,2216) Slack(0) FuelSlack(0,0) Distance(
    35752) -> 43 Fuel(66273) Time(1110,2252) Slack(0)
    FuelSlack(0,0) Distance(36905) -> 42 Fuel(59662)
    Time(1143,2285) Slack(0) FuelSlack(0,0) Distance(
    38007) -> 41 Fuel(52744) Time(1261,2319) Slack(0)
    FuelSlack(0,0) Distance(39160) -> 40 Fuel(45826)
    Time(1415,2353) Slack(0) FuelSlack(0,0) Distance(
    40313) -> 12 Fuel(39215) Time(1568,2386) Slack(798)
```

```

963 FuelSlack(124902,164117) Distance(41415) -> 32 Fuel
    (162798) Time(2996,3814) Slack(0) FuelSlack(0,0)
    Distance(62232) -> 31 Fuel(145752) Time(3082,3900)
    Slack(0) FuelSlack(0,0) Distance(65073) -> 33 Fuel(
    111864) Time(3253,4071) Slack(0) FuelSlack(0,0)
    Distance(70721) -> 34 Fuel(95052) Time(3435,4155)
    Slack(0) FuelSlack(0,0) Distance(73523) -> 35 Fuel(
    78006) Time(3641,4241) Slack(0) FuelSlack(0,0)
    Distance(76364) -> 36 Fuel(61170) Time(3846,4326)
    Slack(0) FuelSlack(0,0) Distance(79170) -> 37 Fuel(
    44358) Time(4050,4410) Slack(0) FuelSlack(0,0)
    Distance(81972) -> 38 Fuel(27312) Time(4256,4496)
    Slack(0) FuelSlack(0,0) Distance(84813) -> 39 Fuel(
    10476) Time(4461,4581) Slack(0) FuelSlack(0,0)
    Distance(87619) -> 13 Fuel(5724) Time(4605,4605)
    Slack(906) FuelSlack(5724,287700) Distance(88411
    ) -> 24 Fuel(287700) Time(5891,5891) Distance(
    100980)

964 Distance of the route: 100980 ft
965 Remaining Fuel of the route: 287700
966 Total Time of the route: 5891 seconds
967
968 Total Distance of all routes: 100980 ft
969 Total Fuel remaining of all routes: 287700
970 Total Time of all routes: 5891 seconds
971 -----
972 UAV optimization via conventional feedforward
    solution
973 -----
974 Start point is: 2
975 Parameters are: 6, 50, 24
976 16
977 16
978 (5.56, 5.89) (5.35, 6.1)
979 10 10
980 The travel time for UGV from depot B to NW UGV stop
    is: 4340
981 The UGV travel time between two UGV stops is: 1121
982 [(0, 60), (0, 14204), (0, 14204), (0, 14204), (0,
    14204), (0, 14204), (0, 14204), (4340, 7340), (4340
    , 7340), (4340, 7340), (4340, 7340), (4340, 7340)
    , (4340, 7340)]

```

```
982 ), (4340, 7340), (8461, 9901), (8461, 9901), (8461  
, 9901), (8461, 9901), (8461, 9901), (8461, 9901  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) , (0, 14204), (0, 14204), (0, 14204), (0, 14204  
) ]  
983 16557254.925754342  
984 End node is [24]  
985 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17, 18, 19, 20, 21, 22, 23]  
986 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
50, 51, 52, 53, 54]  
987 Objective: 2445  
988 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
17 18 19 20 21 22  
989 54  
990 54  
991 54  
992 54  
993 54  
994 54  
995 54  
996 54  
997 54  
998 54  
999 54  
1000 54  
1001 54  
1002 54  
1003 54  
1004 54  
1005 54  
1006 54  
1007 54  
1008 54
```

```
1009 54
1010 54
1011 54
1012 54
1013 54
1014 54
1015 54
1016 54
1017 54
1018 54
1019 54
1020 54
1021 Route for vehicle 0:
1022 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
```

```

1022 Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )

1023 Distance of the route: 81152 ft
1024 Remaining Fuel of the route: 287700
1025 Total Time of the route: 4869 seconds
1026
1027 Total Distance of all routes: 81152 ft
1028 Total Fuel remaining of all routes: 287700
1029 Total Time of all routes: 4869 seconds
1030 Objective value is: 2782
1031 -----
-----  

1032 *****UAV optimization via feedback
    solution*****
1033 -----
-----  

1034 Start point is: 5.125
1035 Parameters are: 5.125, 15.375, 29.449999999999996
1036 16
1037 31
1038 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (

```

```

1038 5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
, 6.26)]}
1039 (5.35, 6.26) (5.77, 5.83)
1040 10 10
1041 The travel time for UGV from depot B to NW UGV stop
is: 1980
1042 The UGV travel time between two UGV stops is: 1322
1043 [(0, 60), (0, 7531), (0, 7531), (0, 7531), (0, 7531
), (0, 7531), (0, 7531), (1980, 2880), (1980, 2880
), (1980, 2880), (1980, 2880), (1980, 2880), (1980
, 2880), (4202, 5942), (4202, 5942), (4202, 5942
), (4202, 5942), (4202, 5942), (4202, 5942), (0,
7531), (0, 7531), (0, 7531), (0, 7531), (0, 7531
), (0, 7531), (0, 7531), (0, 7531), (0, 7531), (0,
7531), (0, 7531), (0, 7531), (0, 7531), (0, 7531
), (0, 7531), (0, 7531), (0, 7531), (0, 7531), (0,
7531), (0, 7531), (0, 7531), (0, 7531), (0, 7531
), (0, 7531), (0, 7531), (0, 7531), (0, 7531), (0,
7531), (0, 7531), (0, 7531), (0, 7531), (0, 7531
), (0, 7531), (0, 7531), (0, 7531)]
1044 7557712.12724779
1045 End node is [24]
1046 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
, 15, 16, 17, 18, 19, 20, 21, 22, 23]
1047 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53]
1048 Objective: 30000000
1049 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33
34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
51 52 53 54
1050 55
1051 Route for vehicle 0:
1052 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 24 Fuel(287700) Time(0,0) Distance(0
)
1053 Distance of the route: 0 ft

```

```
1054 Remaining Fuel of the route: 287700
1055 Total Time of the route: 0 seconds
1056
1057 Total Distance of all routes: 0 ft
1058 Total Fuel remaining of all routes: 287700
1059 Total Time of all routes: 0 seconds
1060 -----
1061 UAV optimization via conventional feedforward
    solution
1062 -----
1063 Start point is: 5
1064 Parameters are: 5, 15, 31
1065 16
1066 31
1067 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
1068 (5.35, 6.26) (5.77, 5.83)
1069 10 10
1070 The travel time for UGV from depot B to NW UGV stop
    is: 1980
1071 The UGV travel time between two UGV stops is: 1322
1072 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651
    ), (0, 7651), (0, 7651), (1980, 2880), (1980, 2880
    ), (1980, 2880), (1980, 2880), (1980, 2880), (1980
    , 2880), (4202, 6062), (4202, 6062), (4202, 6062
    ), (4202, 6062), (4202, 6062), (4202, 6062), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651
    ), (0, 7651), (0, 7651), (0, 7651)]
1073 7581712.12724779
1074 End node is [24]
1075 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
```

```
1075 15, 16, 17, 18, 19, 20, 21, 22, 23]
1076 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53]
1077 Objective: 2445
1078 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
                  17 18 19 20 21 22
1079 54
1080 54
1081 54
1082 54
1083 54
1084 54
1085 54
1086 54
1087 54
1088 54
1089 54
1090 54
1091 54
1092 54
1093 54
1094 54
1095 54
1096 54
1097 54
1098 54
1099 54
1100 54
1101 54
1102 54
1103 54
1104 54
1105 54
1106 54
1107 54
1108 54
1109 54
1110 54
1111 Route for vehicle 0:
1112 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
```

```

1112 Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
(277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(

```

```

1112 75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
      Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
      Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
      41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
      Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
      Slack(846) FuelSlack(24408,287700) Distance(81152
      ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
      )
1113 Distance of the route: 81152 ft
1114 Remaining Fuel of the route: 287700
1115 Total Time of the route: 4869 seconds
1116
1117 Total Distance of all routes: 81152 ft
1118 Total Fuel remaining of all routes: 287700
1119 Total Time of all routes: 4869 seconds
1120 Objective value is: 2662
1121 -----
-----  

1122 *****UAV optimization via feedback
      solution*****
1123 -----
-----  

1124 Start point is: 5.1875
1125 Parameters are: 5.1875, 15.5625, 27.89999999999999
1126 16
1127 31
1128 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
1129 (5.35, 6.26) (5.77, 5.83)
1130 10 10
1131 The travel time for UGV from depot B to NW UGV stop
      is: 1980
1132 The UGV travel time between two UGV stops is: 1322
1133 [(0, 60), (0, 7411), (0, 7411), (0, 7411), (0, 7411
      ), (0, 7411), (0, 7411), (1980, 2880), (1980, 2880
      ), (1980, 2880), (1980, 2880), (1980, 2880), (1980
      , 2880), (4202, 5822), (4202, 5822), (4202, 5822
      )

```

```
1133 ), (4202, 5822), (4202, 5822), (4202, 5822), (0,  
    7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411)  
, (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,  
    7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411)  
, (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,  
    7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411)  
, (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,  
    7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411)  
, (0, 7411), (0, 7411), (0, 7411)]  
1134 7533712.12724779  
1135 End node is [24]  
1136 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
1137 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
    50, 51, 52, 53]  
1138 Objective: 4044  
1139 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
    17 18 19 20 21 22  
1140 54  
1141 54  
1142 54  
1143 54  
1144 54  
1145 54  
1146 54  
1147 54  
1148 54  
1149 54  
1150 54  
1151 54  
1152 54  
1153 54  
1154 54  
1155 54  
1156 54  
1157 54  
1158 54  
1159 54  
1160 54  
1161 54
```

```
1162 54
1163 54
1164 54
1165 54
1166 54
1167 54
1168 54
1169 54
1170 54
1171 54
1172 Route for vehicle 0:
1173 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
```

```

1173 210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(6468,6468) Distance(
    133951)

1174 Distance of the route: 133951 ft
1175 Remaining Fuel of the route: 287700
1176 Total Time of the route: 6468 seconds
1177
1178 Total Distance of all routes: 133951 ft
1179 Total Fuel remaining of all routes: 287700
1180 Total Time of all routes: 6468 seconds
1181 *****Execute updated global
    optimization*****
1182 -----
    -----
1183 *****UAV optimization via feedback
    solution*****
1184 -----
    -----
1185 Start point is: 5
1186 Parameters are: 5, 15, 31
1187 16
1188 31
1189 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5

```

```
1189 : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
1190 (5.35, 6.26) (5.77, 5.83)
1191 10 10
1192 The travel time for UGV from depot B to NW UGV stop
    is: 1980
1193 The UGV travel time between two UGV stops is: 1322
1194 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (1980, 2880), (1980, 2880),
    (1980, 2880), (1980, 2880), (1980, 2880), (1980,
    2880), (4202, 6062), (4202, 6062), (4202, 6062),
    (4202, 6062), (4202, 6062), (4202, 6062), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651)]
1195 7581712.12724779
1196 End node is [24]
1197 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
1198 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53]
1199 Objective: 2445
1200 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
1201 54
1202 54
1203 54
1204 54
1205 54
1206 54
1207 54
1208 54
1209 54
```

```
1210 54
1211 54
1212 54
1213 54
1214 54
1215 54
1216 54
1217 54
1218 54
1219 54
1220 54
1221 54
1222 54
1223 54
1224 54
1225 54
1226 54
1227 54
1228 54
1229 54
1230 54
1231 54
1232 54
1233 Route for vehicle 0:
1234 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
```

```

1234 FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
        34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
        FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
        Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
            36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
        ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
        (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
        Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
        Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
            243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
            Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
            Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
                210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
                Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
                Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
                    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
                    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
                    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
                        142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
                        Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
                        Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
                            108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
                            Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
                            Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
                                75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
                                Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
                                Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
                                    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
                                    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
                                    Slack(846) FuelSlack(24408,287700) Distance(81152
                                ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
                            )
1235 Distance of the route: 81152 ft
1236 Remaining Fuel of the route: 287700
1237 Total Time of the route: 4869 seconds
1238
1239 Total Distance of all routes: 81152 ft
1240 Total Fuel remaining of all routes: 287700
1241 Total Time of all routes: 4869 seconds
1242 Objective value is: 2542

```



```
1259 50, 51, 52, 53]
1260 Objective: 2445
1261 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
1262 54
1263 54
1264 54
1265 54
1266 54
1267 54
1268 54
1269 54
1270 54
1271 54
1272 54
1273 54
1274 54
1275 54
1276 54
1277 54
1278 54
1279 54
1280 54
1281 54
1282 54
1283 54
1284 54
1285 54
1286 54
1287 54
1288 54
1289 54
1290 54
1291 54
1292 54
1293 54
1294 Route for vehicle 0:
1295 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
```

```

1295 26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
(277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(

```

```
1295 41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
)
1296 Distance of the route: 81152 ft
1297 Remaining Fuel of the route: 287700
1298 Total Time of the route: 4869 seconds
1299
1300 Total Distance of all routes: 81152 ft
1301 Total Fuel remaining of all routes: 287700
1302 Total Time of all routes: 4869 seconds
1303 Global population dict is: {(5, 15, 31, 5): 2782, (
6, 50, 24, 3): 7473, (2, 13, 40, 3): 7473}
1304 Global population dict is: {(5, 15, 31, 5): 2782, (
6, 50, 24, 3): 7473, (2, 13, 40, 3): 7473}
1305 Objective: 2445
1306 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
1307 54
1308 54
1309 54
1310 54
1311 54
1312 54
1313 54
1314 54
1315 54
1316 54
1317 54
1318 54
1319 54
1320 54
1321 54
1322 54
1323 54
1324 54
1325 54
1326 54
1327 54
1328 54
```

```
1329 54
1330 54
1331 54
1332 54
1333 54
1334 54
1335 54
1336 54
1337 54
1338 54
1339 Route for vehicle 0:
1340 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
```

```

1340 210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )
1341 Distance of the route: 81152 ft
1342 Remaining Fuel of the route: 287700
1343 Total Time of the route: 4869 seconds
1344
1345 Total Distance of all routes: 81152 ft
1346 Total Fuel remaining of all routes: 287700
1347 Total Time of all routes: 4869 seconds
1348 Objective value is: 2662
1349 -----
-----  

1350 *****UAV optimization via feedback
    solution*****
1351 -----
-----  

1352 Start point is: 5.015625
1353 Parameters are: 5.328125, 14.859375, 28.
    67499999999999
1354 16
1355 31
1356 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5

```

```
1356 : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
1357 (5.35, 6.26) (5.77, 5.83)
1358 10 10
1359 The travel time for UGV from depot B to NW UGV stop is: 1980
1360 The UGV travel time between two UGV stops is: 1322
1361 [(0, 60), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (1980, 2820), (1980, 2820), (1980, 2820), (1980, 2820), (1980, 2820), (1980, 2820), (1980, 2820), (1980, 2820), (4142, 5822), (4142, 5822), (4142, 5822), (4142, 5822), (4142, 5822), (4142, 5822), (4142, 5822), (4142, 5822), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411)]
1362 7533712.12724779
1363 End node is [24]
1364 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23]
1365 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53]
1366 Objective: 2445
1367 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16 17 18 19 20 21 22
1368 54
1369 54
1370 54
1371 54
1372 54
1373 54
1374 54
1375 54
1376 54
```

```
1377 54
1378 54
1379 54
1380 54
1381 54
1382 54
1383 54
1384 54
1385 54
1386 54
1387 54
1388 54
1389 54
1390 54
1391 54
1392 54
1393 54
1394 54
1395 54
1396 54
1397 54
1398 54
1399 54
1400 Route for vehicle 0:
1401 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
```

```

1401 FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
        34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
        FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
        Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
            36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
        ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
        (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
        Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
        Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
            243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
            Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
            Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
                210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
                Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
                Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
                    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
                    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
                    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
                        142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
                        Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
                        Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
                            108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
                            Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
                            Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
                                75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
                                Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
                                Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
                                    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
                                    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
                                    Slack(846) FuelSlack(24408,287700) Distance(81152
                                ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
                            )
1402 Distance of the route: 81152 ft
1403 Remaining Fuel of the route: 287700
1404 Total Time of the route: 4869 seconds
1405
1406 Total Distance of all routes: 81152 ft
1407 Total Fuel remaining of all routes: 287700
1408 Total Time of all routes: 4869 seconds
1409 Objective value is: 2542

```

```
1410 -----
1411 *****UAV optimization via feedback
      solution*****
1412 -----
1413 Start point is: 5.0234375
1414 Parameters are: 5.1171875, 15.5390625, 27.
      51249999999999
1415 16
1416 31
1417 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
1418 (5.35, 6.26) (5.77, 5.83)
1419 10 10
1420 The travel time for UGV from depot B to NW UGV stop
      is: 1980
1421 The UGV travel time between two UGV stops is: 1322
1422 [(0, 60), (0, 7411), (0, 7411), (0, 7411), (0, 7411),
      (0, 7411), (0, 7411), (1980, 2880), (1980, 2880),
      (1980, 2880), (1980, 2880), (1980, 2880), (1980,
      2880), (4202, 5822), (4202, 5822), (4202, 5822),
      (4202, 5822), (4202, 5822), (4202, 5822), (0,
      7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411),
      (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,
      7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411),
      (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,
      7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411),
      (0, 7411), (0, 7411), (0, 7411), (0, 7411), (0,
      7411), (0, 7411), (0, 7411), (0, 7411), (0, 7411),
      (0, 7411), (0, 7411), (0, 7411), (0, 7411)]
1423 7533712.12724779
1424 End node is [24]
1425 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
1426 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
      38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
```

```
1426 50, 51, 52, 53]
1427 Objective: 2445
1428 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
1429 54
1430 54
1431 54
1432 54
1433 54
1434 54
1435 54
1436 54
1437 54
1438 54
1439 54
1440 54
1441 54
1442 54
1443 54
1444 54
1445 54
1446 54
1447 54
1448 54
1449 54
1450 54
1451 54
1452 54
1453 54
1454 54
1455 54
1456 54
1457 54
1458 54
1459 54
1460 54
1461 Route for vehicle 0:
1462 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
```

```

1462 26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
(277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(

```

```

1462 41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )
1463 Distance of the route: 81152 ft
1464 Remaining Fuel of the route: 287700
1465 Total Time of the route: 4869 seconds
1466
1467 Total Distance of all routes: 81152 ft
1468 Total Fuel remaining of all routes: 287700
1469 Total Time of all routes: 4869 seconds
1470 Objective value is: 2542
1471 -----
-----  

1472 *****UAV optimization via feedback
    solution*****
1473 -----
-----  

1474 Start point is: 5.03515625
1475 Parameters are: 5.42578125, 15.80859375, 25.
    768749999999983
1476 16
1477 31
1478 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
1479 (5.35, 6.26) (5.77, 5.83)
1480 10 10
1481 The travel time for UGV from depot B to NW UGV stop
    is: 1980
1482 The UGV travel time between two UGV stops is: 1322
1483 [(0, 60), (0, 7291), (0, 7291), (0, 7291), (0, 7291
    ), (0, 7291), (0, 7291), (1980, 2880), (1980, 2880
    ), (1980, 2880), (1980, 2880), (1980, 2880), (1980
    , 2880), (4202, 5702), (4202, 5702), (4202, 5702
    ), (4202, 5702), (4202, 5702), (4202, 5702), (0,
    7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291)
    ]

```

```
1483 ), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0,  
    7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291  
, (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0,  
    7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291  
, (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291), (0,  
    7291), (0, 7291), (0, 7291), (0, 7291), (0, 7291)]  
1484 7509712.12724779  
1485 End node is [24]  
1486 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
1487 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
    50, 51, 52, 53]  
1488 Objective: 2445  
1489 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
    17 18 19 20 21 22  
1490 54  
1491 54  
1492 54  
1493 54  
1494 54  
1495 54  
1496 54  
1497 54  
1498 54  
1499 54  
1500 54  
1501 54  
1502 54  
1503 54  
1504 54  
1505 54  
1506 54  
1507 54  
1508 54  
1509 54  
1510 54  
1511 54  
1512 54  
1513 54
```

```

1514 54
1515 54
1516 54
1517 54
1518 54
1519 54
1520 54
1521 54
1522 Route for vehicle 0:
1523 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)

```

```

1523 Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )

1524 Distance of the route: 81152 ft
1525 Remaining Fuel of the route: 287700
1526 Total Time of the route: 4869 seconds
1527
1528 Total Distance of all routes: 81152 ft
1529 Total Fuel remaining of all routes: 287700
1530 Total Time of all routes: 4869 seconds
1531 Objective value is: 2422
1532 -----
-----  

1533 *****UAV optimization via feedback
    solution*****
1534 -----
-----  

1535 Start point is: 5.052734375
1536 Parameters are: 5.638671875, 16.212890625, 23.
    153124999999974
1537 16
1538 31
1539 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    5.35, 6.1)]}

```

```
1539 .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35  
, 6.26)]}  
1540 (5.35, 6.26) (5.77, 5.83)  
1541 10 10  
1542 The travel time for UGV from depot B to NW UGV stop  
is: 1980  
1543 The UGV travel time between two UGV stops is: 1322  
1544 [(0, 60), (0, 7231), (0, 7231), (0, 7231), (0, 7231  
, (0, 7231), (0, 7231), (1980, 2940), (1980, 2940  
, (1980, 2940), (1980, 2940), (1980, 2940), (1980  
, 2940), (4262, 5642), (4262, 5642), (4262, 5642  
, (4262, 5642), (4262, 5642), (4262, 5642), (0,  
7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231  
, (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,  
7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231  
, (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,  
7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231  
, (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,  
7231), (0, 7231), (0, 7231), (0, 7231)]  
1545 7497712.12724779  
1546 End node is [24]  
1547 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17, 18, 19, 20, 21, 22, 23]  
1548 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
50, 51, 52, 53]  
1549 Objective: 2445  
1550 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
17 18 19 20 21 22  
1551 54  
1552 54  
1553 54  
1554 54  
1555 54  
1556 54  
1557 54  
1558 54  
1559 54  
1560 54  
1561 54
```

```
1562 54
1563 54
1564 54
1565 54
1566 54
1567 54
1568 54
1569 54
1570 54
1571 54
1572 54
1573 54
1574 54
1575 54
1576 54
1577 54
1578 54
1579 54
1580 54
1581 54
1582 54
1583 Route for vehicle 0:
1584 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
        0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
        26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
        FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
        Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
            28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
        FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
        Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
            29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
        FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
        Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
            31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
        FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
        Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
            33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
        FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
        Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
```

```

1584 34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
    277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )

1585 Distance of the route: 81152 ft
1586 Remaining Fuel of the route: 287700
1587 Total Time of the route: 4869 seconds
1588
1589 Total Distance of all routes: 81152 ft
1590 Total Fuel remaining of all routes: 287700
1591 Total Time of all routes: 4869 seconds
1592 Objective value is: 2362
1593 -----
-----
```

```

1594 ****UAV optimization via feedback
      solution*****
1595 -----
      -----
1596 Start point is: 5.2958984375
1597 Parameters are: 5.4169921875, 15.4306640625, 24.
      17031249999998
1598 16
1599 31
1600 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
1601 (5.35, 6.26) (5.77, 5.83)
1602 10 10
1603 The travel time for UGV from depot B to NW UGV stop
      is: 1980
1604 The UGV travel time between two UGV stops is: 1322
1605 [(0, 60), (0, 7231), (0, 7231), (0, 7231), (0, 7231
      ), (0, 7231), (0, 7231), (1980, 2880), (1980, 2880
      ), (1980, 2880), (1980, 2880), (1980, 2880), (1980
      , 2880), (4202, 5642), (4202, 5642), (4202, 5642
      ), (4202, 5642), (4202, 5642), (4202, 5642), (0,
      7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
      ), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,
      7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
      ), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,
      7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
      ), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,
      7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
      ), (0, 7231), (0, 7231), (0, 7231)]
1606 7497712.12724779
1607 End node is [24]
1608 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
1609 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53]
1610 Objective: 2445

```

```
1611 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
1612 17 18 19 20 21 22  
1613 54  
1614 54  
1615 54  
1616 54  
1617 54  
1618 54  
1619 54  
1620 54  
1621 54  
1622 54  
1623 54  
1624 54  
1625 54  
1626 54  
1627 54  
1628 54  
1629 54  
1630 54  
1631 54  
1632 54  
1633 54  
1634 54  
1635 54  
1636 54  
1637 54  
1638 54  
1639 54  
1640 54  
1641 54  
1642 54  
1643 54  
1644 Route for vehicle 0:  
1645 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)  
Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(  
0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384  
) Time(798,978) Slack(0) FuelSlack(0,0) Distance(  
26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)  
FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
```

```

1645 Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
(277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)

```

```

1645 Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )
1646 Distance of the route: 81152 ft
1647 Remaining Fuel of the route: 287700
1648 Total Time of the route: 4869 seconds
1649
1650 Total Distance of all routes: 81152 ft
1651 Total Fuel remaining of all routes: 287700
1652 Total Time of all routes: 4869 seconds
1653 Objective value is: 2362
1654 -----
-----
1655 *****UAV optimization via feedback
solution*****
1656 -----
-----
1657 Start point is: 5.25244140625
1658 Parameters are: 5.66845703125, 15.49365234375, 24.
436718749999983
1659 16
1660 31
1661 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
, 6.26)]}
1662 (5.35, 6.26) (5.77, 5.83)
1663 10 10
1664 The travel time for UGV from depot B to NW UGV stop
is: 1980
1665 The UGV travel time between two UGV stops is: 1322
1666 [(0, 60), (0, 7231), (0, 7231), (0, 7231), (0, 7231
), (0, 7231), (0, 7231), (1980, 2880), (1980, 2880
), (1980, 2880), (1980, 2880), (1980, 2880), (1980
, 2880), (4202, 5642), (4202, 5642), (4202, 5642
), (4202, 5642), (4202, 5642), (4202, 5642), (0,
7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,
7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231
), (0, 7231), (0, 7231), (0, 7231), (0, 7231)

```

```
1666 ), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0,
    7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231),
    ), (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231),
    (0, 7231), (0, 7231), (0, 7231), (0, 7231), (0, 7231),
    (0, 7231), (0, 7231), (0, 7231)]
1667 7497712.12724779
1668 End node is [24]
1669 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
1670 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53]
1671 Objective: 2445
1672 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22
1673 54
1674 54
1675 54
1676 54
1677 54
1678 54
1679 54
1680 54
1681 54
1682 54
1683 54
1684 54
1685 54
1686 54
1687 54
1688 54
1689 54
1690 54
1691 54
1692 54
1693 54
1694 54
1695 54
1696 54
1697 54
1698 54
```

```

1699 54
1700 54
1701 54
1702 54
1703 54
1704 54
1705 Route for vehicle 0:
1706 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
    (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)

```

```

1706 Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )

1707 Distance of the route: 81152 ft
1708 Remaining Fuel of the route: 287700
1709 Total Time of the route: 4869 seconds
1710
1711 Total Distance of all routes: 81152 ft
1712 Total Fuel remaining of all routes: 287700
1713 Total Time of all routes: 4869 seconds
1714 Objective value is: 2362
1715 -----
-----  

1716 *****UAV optimization via feedback
    solution*****
1717 -----
-----  

1718 Start point is: 5.378662109375
1719 Parameters are: 5.627685546875, 16.490478515625, 21
    .155078124999967
1720 16
1721 31
1722 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}

```

1723 (5.35, 6.26) (5.77, 5.83)
1724 10 10
1725 The travel time for UGV from depot B to NW UGV stop
is: 1980
1726 The UGV travel time between two UGV stops is: 1322
1727 [(0, 60), (0, 7111), (0, 7111), (0, 7111), (0, 7111),
(0, 7111), (0, 7111), (1980, 2940), (1980, 2940),
(1980, 2940), (1980, 2940), (1980, 2940), (1980,
2940), (4262, 5522), (4262, 5522), (4262, 5522),
(4262, 5522), (4262, 5522), (4262, 5522), (0,
7111), (0, 7111), (0, 7111), (0, 7111), (0, 7111),
(0, 7111), (0, 7111), (0, 7111), (0, 7111), (0,
7111), (0, 7111), (0, 7111), (0, 7111), (0, 7111),
(0, 7111), (0, 7111), (0, 7111), (0, 7111), (0,
7111), (0, 7111), (0, 7111), (0, 7111), (0, 7111),
(0, 7111), (0, 7111), (0, 7111), (0, 7111), (0,
7111), (0, 7111), (0, 7111), (0, 7111), (0, 7111),
(0, 7111), (0, 7111), (0, 7111), (0, 7111), (0,
7111), (0, 7111), (0, 7111), (0, 7111), (0, 7111)]
1728 7473712.12724779
1729 End node is [24]
1730 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
1731 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53]
1732 Objective: 2445
1733 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22
1734 54
1735 54
1736 54
1737 54
1738 54
1739 54
1740 54
1741 54
1742 54
1743 54
1744 54
1745 54
1746 54

```
1747 54
1748 54
1749 54
1750 54
1751 54
1752 54
1753 54
1754 54
1755 54
1756 54
1757 54
1758 54
1759 54
1760 54
1761 54
1762 54
1763 54
1764 54
1765 54
1766 Route for vehicle 0:
1767 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
        0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
        26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
        28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
        29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
        31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
        33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
        34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
```

```

1767 Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
Slack(846) FuelSlack(24408,287700) Distance(81152
) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
)

1768 Distance of the route: 81152 ft
1769 Remaining Fuel of the route: 287700
1770 Total Time of the route: 4869 seconds
1771
1772 Total Distance of all routes: 81152 ft
1773 Total Fuel remaining of all routes: 287700
1774 Total Time of all routes: 4869 seconds
1775 Objective value is: 2242
1776 -----
-----  

1777 *****UAV optimization via feedback
solution*****
```

```

1778 -----
-----
1779 Start point is: 5.5601806640625
1780 Parameters are: 5.7774658203125, 17.3060302734375,
17.39511718749995
1781 16
1782 31
1783 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
, 6.26)]}
1784 (5.35, 6.26) (5.77, 5.83)
1785 10 10
1786 The travel time for UGV from depot B to NW UGV stop
is: 1980
1787 The UGV travel time between two UGV stops is: 1322
1788 [(0, 60), (0, 6931), (0, 6931), (0, 6931), (0, 6931
), (0, 6931), (0, 6931), (1980, 3000), (1980, 3000
), (1980, 3000), (1980, 3000), (1980, 3000), (1980
, 3000), (4322, 5342), (4322, 5342), (4322, 5342
), (4322, 5342), (4322, 5342), (4322, 5342), (0,
6931), (0, 6931), (0, 6931), (0, 6931), (0, 6931
), (0, 6931), (0, 6931), (0, 6931), (0, 6931), (0,
6931), (0, 6931), (0, 6931), (0, 6931), (0, 6931
), (0, 6931), (0, 6931), (0, 6931), (0, 6931), (0,
6931), (0, 6931), (0, 6931), (0, 6931), (0, 6931
), (0, 6931), (0, 6931), (0, 6931), (0, 6931), (0,
6931), (0, 6931), (0, 6931), (0, 6931), (0, 6931
), (0, 6931), (0, 6931), (0, 6931)]
1789 7437712.12724779
1790 End node is [24]
1791 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
1792 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53]
1793 Objective: 2445
1794 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22

```

```
1795 54
1796 54
1797 54
1798 54
1799 54
1800 54
1801 54
1802 54
1803 54
1804 54
1805 54
1806 54
1807 54
1808 54
1809 54
1810 54
1811 54
1812 54
1813 54
1814 54
1815 54
1816 54
1817 54
1818 54
1819 54
1820 54
1821 54
1822 54
1823 54
1824 54
1825 54
1826 54
1827 Route for vehicle 0:
1828 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
        0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
        26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
        FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
        Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
            28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
```

```

1828 FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
    (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )

```



```
1849 ), (0, 6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),
       (0, 6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),
       (0, 6646), (0, 6646), (0, 6646), (0, 6646)]
1850 7121176.818043279
1851 End node is [24]
1852 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
       15, 16, 17, 18, 19, 20, 21, 22, 23]
1853 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
       , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
       50, 51, 52, 53, 54]
1854 Objective: 2498
1855 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
       17 18 19 20 21 22
1856 55
1857 55
1858 55
1859 55
1860 55
1861 55
1862 55
1863 55
1864 55
1865 55
1866 55
1867 55
1868 55
1869 55
1870 55
1871 55
1872 55
1873 55
1874 55
1875 55
1876 55
1877 55
1878 55
1879 55
1880 55
1881 55
1882 55
1883 55
```

```

1884 55
1885 55
1886 55
1887 55
1888 55
1889 Route for vehicle 0:
1890 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
  0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
  ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
  26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
  FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
  Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
  28024) -> 29 Fuel(114486) Time(872,1373) Slack(0)
  FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
  Time(897,1398) Slack(0) FuelSlack(0,0) Distance(
  29715) -> 31 Fuel(104340) Time(922,1423) Slack(0)
  FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
  Time(947,1448) Slack(0) FuelSlack(0,0) Distance(
  31405) -> 33 Fuel(94194) Time(972,1473) Slack(0)
  FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
  Time(997,1498) Slack(0) FuelSlack(0,0) Distance(
  33096) -> 35 Fuel(84372) Time(1021,1522) Slack(0)
  FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
  Time(1046,1547) Slack(0) FuelSlack(0,0) Distance(
  34734) -> 37 Fuel(74226) Time(1092,1572) Slack(0)
  FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
  Time(1237,1597) Slack(0) FuelSlack(0,0) Distance(
  36424) -> 39 Fuel(64080) Time(1382,1622) Slack(0)
  FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258)
  Time(1551,1671) Slack(0) FuelSlack(0,0) Distance(
  38907) -> 12 Fuel(47340) Time(1705,1705) Slack(772
  ) FuelSlack(68052,68094) Distance(40060) -> 53 Fuel(
  266946) Time(2581,2581) Slack(0) FuelSlack(0,0)
  Distance(43519) -> 52 Fuel(249900) Time(2667,2667)
  Slack(0) FuelSlack(0,0) Distance(46360) -> 51 Fuel(
  233088) Time(2751,2751) Slack(0) FuelSlack(0,0)
  Distance(49162) -> 50 Fuel(216252) Time(2836,2836)
  Slack(0) FuelSlack(0,0) Distance(51968) -> 49 Fuel(
  199206) Time(2922,2922) Slack(0) FuelSlack(0,0)
  Distance(54809) -> 48 Fuel(182394) Time(3006,3006)

```

```

1890 Slack(0) FuelSlack(0,0) Distance(57611) -> 47 Fuel(
    165558) Time(3091,3091) Slack(0) FuelSlack(0,0)
    Distance(60417) -> 46 Fuel(148512) Time(3177,3177)
    Slack(0) FuelSlack(0,0) Distance(63258) -> 45 Fuel(
    131700) Time(3261,3261) Slack(0) FuelSlack(0,0)
    Distance(66060) -> 44 Fuel(114654) Time(3347,3347)
    Slack(0) FuelSlack(0,0) Distance(68901) -> 43 Fuel(
    98052) Time(3430,3430) Slack(0) FuelSlack(0,0)
    Distance(71668) -> 42 Fuel(81006) Time(3516,3516)
    Slack(0) FuelSlack(0,0) Distance(74509) -> 41 Fuel(
    63960) Time(3602,3602) Slack(0) FuelSlack(0,0)
    Distance(77350) -> 40 Fuel(47358) Time(3685,3685)
    Slack(0) FuelSlack(0,0) Distance(80117) -> 23 Fuel(
    30312) Time(3771,3771) Slack(827) FuelSlack(30312,
    287700) Distance(82958) -> 24 Fuel(287700) Time(
    4598,4598) Distance(82958)

1891 Distance of the route: 82958 ft
1892 Remaining Fuel of the route: 287700
1893 Total Time of the route: 4598 seconds
1894
1895 Total Distance of all routes: 82958 ft
1896 Total Fuel remaining of all routes: 287700
1897 Total Time of all routes: 4598 seconds
1898 Objective value is: 2048
1899 -----
-----  

1900 *****UAV optimization via feedback
solution*****
1901 -----
-----  

1902 Start point is: 5.495941162109375
1903 Parameters are: 6.501190185546875, 17.
    207427978515625, 11.066455078124932
1904 16
1905 31
1906 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}

```

```
1907 (5.56, 5.89) (5.35, 6.1)
1908 10 10
1909 The travel time for UGV from depot B to NW UGV stop
      is: 1705
1910 The UGV travel time between two UGV stops is: 1121
1911 [(0, 60), (0, 6406), (0, 6406), (0, 6406), (0, 6406),
      ), (0, 6406), (0, 6406), (1705, 2725), (1705, 2725),
      ), (1705, 2725), (1705, 2725), (1705, 2725), (1705,
      , 2725), (3846, 4506), (3846, 4506), (3846, 4506),
      ), (3846, 4506), (3846, 4506), (3846, 4506), (0,
      6406), (0, 6406), (0, 6406), (0, 6406), (0, 6406),
      ), (0, 6406), (0, 6406), (0, 6406), (0, 6406), (0,
      6406), (0, 6406), (0, 6406), (0, 6406), (0, 6406),
      ), (0, 6406), (0, 6406), (0, 6406), (0, 6406), (0,
      6406), (0, 6406), (0, 6406), (0, 6406), (0, 6406),
      ), (0, 6406), (0, 6406), (0, 6406), (0, 6406), (0,
      6406), (0, 6406), (0, 6406), (0, 6406)]
1912 7073176.818043279
1913 End node is [24]
1914 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
1915 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
1916 Objective: 2498
1917 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
      17 18 19 20 21 22
1918 55
1919 55
1920 55
1921 55
1922 55
1923 55
1924 55
1925 55
1926 55
1927 55
1928 55
1929 55
1930 55
```

```
1931 55
1932 55
1933 55
1934 55
1935 55
1936 55
1937 55
1938 55
1939 55
1940 55
1941 55
1942 55
1943 55
1944 55
1945 55
1946 55
1947 55
1948 55
1949 55
1950 55
1951 Route for vehicle 0:
1952 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1373) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1398) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1423) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(947,1448) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(972,1473) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(997,1498) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1021,1522) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1046,1547) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1092,1572) Slack(0)
```

```

1952 FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1237,1597) Slack(0) FuelSlack(0,0) Distance(
        36424) -> 39 Fuel(64080) Time(1382,1622) Slack(0)
        FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258)
        Time(1551,1671) Slack(0) FuelSlack(0,0) Distance(
            38907) -> 12 Fuel(47340) Time(1705,1705) Slack(772
        ) FuelSlack(68052,68094) Distance(40060) -> 53 Fuel
        (266946) Time(2581,2581) Slack(0) FuelSlack(0,0)
        Distance(43519) -> 52 Fuel(249900) Time(2667,2667)
        Slack(0) FuelSlack(0,0) Distance(46360) -> 51 Fuel(
            233088) Time(2751,2751) Slack(0) FuelSlack(0,0)
            Distance(49162) -> 50 Fuel(216252) Time(2836,2836)
            Slack(0) FuelSlack(0,0) Distance(51968) -> 49 Fuel(
                199206) Time(2922,2922) Slack(0) FuelSlack(0,0)
                Distance(54809) -> 48 Fuel(182394) Time(3006,3006)
                Slack(0) FuelSlack(0,0) Distance(57611) -> 47 Fuel(
                    165558) Time(3091,3091) Slack(0) FuelSlack(0,0)
                    Distance(60417) -> 46 Fuel(148512) Time(3177,3177)
                    Slack(0) FuelSlack(0,0) Distance(63258) -> 45 Fuel(
                        131700) Time(3261,3261) Slack(0) FuelSlack(0,0)
                        Distance(66060) -> 44 Fuel(114654) Time(3347,3347)
                        Slack(0) FuelSlack(0,0) Distance(68901) -> 43 Fuel(
                            98052) Time(3430,3430) Slack(0) FuelSlack(0,0)
                            Distance(71668) -> 42 Fuel(81006) Time(3516,3516)
                            Slack(0) FuelSlack(0,0) Distance(74509) -> 41 Fuel(
                                63960) Time(3602,3602) Slack(0) FuelSlack(0,0)
                                Distance(77350) -> 40 Fuel(47358) Time(3685,3685)
                                Slack(0) FuelSlack(0,0) Distance(80117) -> 23 Fuel(
                                    30312) Time(3771,3771) Slack(827) FuelSlack(30312,
                                        287700) Distance(82958) -> 24 Fuel(287700) Time(
                                            4598,4598) Distance(82958)

1953 Distance of the route: 82958 ft
1954 Remaining Fuel of the route: 287700
1955 Total Time of the route: 4598 seconds
1956
1957 Total Distance of all routes: 82958 ft
1958 Total Fuel remaining of all routes: 287700
1959 Total Time of all routes: 4598 seconds
1960 Objective value is: 1808
1961 -----
-----
```

```

1962 ****UAV optimization via feedback
      solution*****
1963 -----
      -----
1964 Start point is: 5.4499359130859375
1965 Parameters are: 5.9987030029296875, 17.
                  584854125976562, 13.455786132812435
1966 16
1967 31
1968 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
1969 (5.35, 6.26) (5.77, 5.83)
1970 10 10
1971 The travel time for UGV from depot B to NW UGV stop
      is: 1980
1972 The UGV travel time between two UGV stops is: 1322
1973 [(0, 60), (0, 6691), (0, 6691), (0, 6691), (0, 6691
      ), (0, 6691), (0, 6691), (1980, 3000), (1980, 3000
      ), (1980, 3000), (1980, 3000), (1980, 3000), (1980
      , 3000), (4322, 5102), (4322, 5102), (4322, 5102
      ), (4322, 5102), (4322, 5102), (4322, 5102), (0,
      6691), (0, 6691), (0, 6691), (0, 6691), (0, 6691
      ), (0, 6691), (0, 6691), (0, 6691), (0, 6691), (0,
      6691), (0, 6691), (0, 6691), (0, 6691), (0, 6691
      ), (0, 6691), (0, 6691), (0, 6691), (0, 6691), (0,
      6691), (0, 6691), (0, 6691), (0, 6691), (0, 6691
      ), (0, 6691), (0, 6691), (0, 6691), (0, 6691)]
1974 7389712.12724779
1975 End node is [24]
1976 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
1977 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53]
1978 Objective: 2445

```

1979	Dropped nodes:	1	2	3	4	5	6	7	8	9	10	11	13	14	15	16
		17	18	19	20	21	22									
1980	54															
1981	54															
1982	54															
1983	54															
1984	54															
1985	54															
1986	54															
1987	54															
1988	54															
1989	54															
1990	54															
1991	54															
1992	54															
1993	54															
1994	54															
1995	54															
1996	54															
1997	54															
1998	54															
1999	54															
2000	54															
2001	54															
2002	54															
2003	54															
2004	54															
2005	54															
2006	54															
2007	54															
2008	54															
2009	54															
2010	54															
2011	54															
2012	Route for vehicle 0:															
2013	0	Fuel(287700)	Time(0,0)	Slack(0)	FuelSlack(0,0)											
		Distance(0)	-> 25	Fuel(134454)	Time(773,833)	Slack(0)										
		FuelSlack(0,0)	Distance(25541)	-> 26	Fuel(129384))	Time(798,978)	Slack(0)	FuelSlack(0,0)	Distance(26386)	-> 27	Fuel(124308)	Time(823,1123)	Slack(0)		
		FuelSlack(0,0)	Distance(27232)	-> 28	Fuel(119556)											

```

2013 Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
(277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
Distance(78311) -> 23 Fuel(24408) Time(4023,4023)

```



```
2034 ), (0, 6286), (0, 6286), (0, 6286), (0, 6286), (0,
6286), (0, 6286), (0, 6286), (0, 6286), (0, 6286),
), (0, 6286), (0, 6286), (0, 6286), (0, 6286), (0,
6286), (0, 6286), (0, 6286), (0, 6286), (0, 6286)
), (0, 6286), (0, 6286), (0, 6286), (0, 6286)]  
2035 7049176.818043279  
2036 End node is [24]  
2037 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]  
2038 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53, 54]  
2039 Objective: 2498  
2040 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22  
2041 55  
2042 55  
2043 55  
2044 55  
2045 55  
2046 55  
2047 55  
2048 55  
2049 55  
2050 55  
2051 55  
2052 55  
2053 55  
2054 55  
2055 55  
2056 55  
2057 55  
2058 55  
2059 55  
2060 55  
2061 55  
2062 55  
2063 55  
2064 55  
2065 55  
2066 55
```

```

2067 55
2068 55
2069 55
2070 55
2071 55
2072 55
2073 55
2074 Route for vehicle 0:
2075 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
  0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
  ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
  26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
  FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
  Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
  28024) -> 29 Fuel(114486) Time(872,1373) Slack(0)
  FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
  Time(897,1398) Slack(0) FuelSlack(0,0) Distance(
  29715) -> 31 Fuel(104340) Time(922,1423) Slack(0)
  FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
  Time(947,1448) Slack(0) FuelSlack(0,0) Distance(
  31405) -> 33 Fuel(94194) Time(972,1473) Slack(0)
  FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
  Time(997,1498) Slack(0) FuelSlack(0,0) Distance(
  33096) -> 35 Fuel(84372) Time(1021,1522) Slack(0)
  FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
  Time(1046,1547) Slack(0) FuelSlack(0,0) Distance(
  34734) -> 37 Fuel(74226) Time(1092,1572) Slack(0)
  FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
  Time(1237,1597) Slack(0) FuelSlack(0,0) Distance(
  36424) -> 39 Fuel(64080) Time(1382,1622) Slack(0)
  FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258)
  Time(1551,1671) Slack(0) FuelSlack(0,0) Distance(
  38907) -> 12 Fuel(47340) Time(1705,1705) Slack(772
  ) FuelSlack(68052,68094) Distance(40060) -> 53 Fuel(
  266946) Time(2581,2581) Slack(0) FuelSlack(0,0)
  Distance(43519) -> 52 Fuel(249900) Time(2667,2667)
  Slack(0) FuelSlack(0,0) Distance(46360) -> 51 Fuel(
  233088) Time(2751,2751) Slack(0) FuelSlack(0,0)
  Distance(49162) -> 50 Fuel(216252) Time(2836,2836)
  Slack(0) FuelSlack(0,0) Distance(51968) -> 49 Fuel(

```

```

2075 199206) Time(2922,2922) Slack(0) FuelSlack(0,0)
    Distance(54809) -> 48 Fuel(182394) Time(3006,3006)
    Slack(0) FuelSlack(0,0) Distance(57611) -> 47 Fuel(
    165558) Time(3091,3091) Slack(0) FuelSlack(0,0)
    Distance(60417) -> 46 Fuel(148512) Time(3177,3177)
    Slack(0) FuelSlack(0,0) Distance(63258) -> 45 Fuel(
    131700) Time(3261,3261) Slack(0) FuelSlack(0,0)
    Distance(66060) -> 44 Fuel(114654) Time(3347,3347)
    Slack(0) FuelSlack(0,0) Distance(68901) -> 43 Fuel(
    98052) Time(3430,3430) Slack(0) FuelSlack(0,0)
    Distance(71668) -> 42 Fuel(81006) Time(3516,3516)
    Slack(0) FuelSlack(0,0) Distance(74509) -> 41 Fuel(
    63960) Time(3602,3602) Slack(0) FuelSlack(0,0)
    Distance(77350) -> 40 Fuel(47358) Time(3685,3685)
    Slack(0) FuelSlack(0,0) Distance(80117) -> 23 Fuel(
    30312) Time(3771,3771) Slack(827) FuelSlack(30312,
    287700) Distance(82958) -> 24 Fuel(287700) Time(
    4598,4598) Distance(82958)
2076 Distance of the route: 82958 ft
2077 Remaining Fuel of the route: 287700
2078 Total Time of the route: 4598 seconds
2079
2080 Total Distance of all routes: 82958 ft
2081 Total Fuel remaining of all routes: 287700
2082 Total Time of all routes: 4598 seconds
2083 Objective value is: 1688
2084 -----
-----  

2085 *****UAV optimization via feedback
    solution*****
2086 -----
-----  

2087 Start point is: 5.577297210693359
2088 Parameters are: 7.103038787841797, 20.
    372074127197266, 0.46223754882800705
2089 16
2090 31
2091 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .35, 6.1), (5.77, 5.83)]}

```

```
2091 .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35  
, 6.26)]}  
2092 (5.77, 5.83) (5.35, 6.1)  
2093 10 10  
2094 The travel time for UGV from depot B to NW UGV stop  
is: 1589  
2095 The UGV travel time between two UGV stops is: 1237  
2096 [(0, 60), (0, 5926), (0, 5926), (0, 5926), (0, 5926  
, (0, 5926), (0, 5926), (1589, 2789), (1589, 2789  
, (1589, 2789), (1589, 2789), (1589, 2789), (1589  
, 2789), (4026, 4026), (4026, 4026), (4026, 4026  
, (4026, 4026), (4026, 4026), (4026, 4026), (0,  
5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926  
, (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,  
5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926  
, (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,  
5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926  
, (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,  
5926), (0, 5926), (0, 5926), (0, 5926)]  
2097 6977176.8180432785  
2098 End node is [24]  
2099 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17, 18, 19, 20, 21, 22, 23]  
2100 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
50, 51, 52, 53, 54]  
2101 Objective: 2560  
2102 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
17 18 19 20 21 22  
2103 55  
2104 55  
2105 55  
2106 55  
2107 55  
2108 55  
2109 55  
2110 55  
2111 55  
2112 55  
2113 55
```

```
2114 55
2115 55
2116 55
2117 55
2118 55
2119 55
2120 55
2121 55
2122 55
2123 55
2124 55
2125 55
2126 55
2127 55
2128 55
2129 55
2130 55
2131 55
2132 55
2133 55
2134 55
2135 55
2136 Route for vehicle 0:
2137 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
        0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
        26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1197) Slack(0) FuelSlack(0,0) Distance(
        28024) -> 29 Fuel(114486) Time(872,1222) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1247) Slack(0) FuelSlack(0,0) Distance(
        29715) -> 31 Fuel(104340) Time(922,1272) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(947,1297) Slack(0) FuelSlack(0,0) Distance(
        31405) -> 33 Fuel(94194) Time(972,1322) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(997,1347) Slack(0) FuelSlack(0,0) Distance(
        33096) -> 35 Fuel(84372) Time(1021,1371) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
```

```

2137 Time(1046,1396) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1071,1421) Slack(0)
FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
Time(1096,1446) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 39 Fuel(64080) Time(1231,1471) Slack(0)
FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258)
Time(1400,1520) Slack(0) FuelSlack(0,0) Distance(
    38907) -> 12 Fuel(40422) Time(1589,1589) Slack(795
) FuelSlack(66101,66378) Distance(41213) -> 53 Fuel
(261744) Time(2515,2515) Slack(0) FuelSlack(0,0)
Distance(45539) -> 52 Fuel(244698) Time(2601,2601)
Slack(0) FuelSlack(0,0) Distance(48380) -> 51 Fuel(
227886) Time(2685,2685) Slack(0) FuelSlack(0,0)
Distance(51182) -> 50 Fuel(211050) Time(2770,2770)
Slack(0) FuelSlack(0,0) Distance(53988) -> 49 Fuel(
194004) Time(2856,2856) Slack(0) FuelSlack(0,0)
Distance(56829) -> 48 Fuel(177192) Time(2940,2940)
Slack(0) FuelSlack(0,0) Distance(59631) -> 47 Fuel(
160356) Time(3025,3025) Slack(0) FuelSlack(0,0)
Distance(62437) -> 46 Fuel(143310) Time(3111,3111)
Slack(0) FuelSlack(0,0) Distance(65278) -> 45 Fuel(
126498) Time(3195,3195) Slack(0) FuelSlack(0,0)
Distance(68080) -> 44 Fuel(109452) Time(3281,3281)
Slack(0) FuelSlack(0,0) Distance(70921) -> 43 Fuel(
92850) Time(3364,3364) Slack(0) FuelSlack(0,0)
Distance(73688) -> 42 Fuel(75804) Time(3450,3450)
Slack(0) FuelSlack(0,0) Distance(76529) -> 41 Fuel(
58758) Time(3536,3536) Slack(0) FuelSlack(0,0)
Distance(79370) -> 40 Fuel(42156) Time(3619,3619)
Slack(0) FuelSlack(0,0) Distance(82137) -> 23 Fuel(
25110) Time(3705,3705) Slack(844) FuelSlack(25110,
287700) Distance(84978) -> 24 Fuel(287700) Time(
4549,4549) Distance(84978)

2138 Distance of the route: 84978 ft
2139 Remaining Fuel of the route: 287700
2140 Total Time of the route: 4549 seconds
2141
2142 Total Distance of all routes: 84978 ft
2143 Total Fuel remaining of all routes: 287700
2144 Total Time of all routes: 4549 seconds
2145 Objective value is: 1377

```

```
2146 -----
2147 UAV optimization via conventional feedforward
      solution
2148 -----
2149 Start point is: 5
2150 Parameters are: 7, 20, 0
2151 16
2152 31
2153 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
2154 (5.77, 5.83) (5.35, 6.1)
2155 10 10
2156 The travel time for UGV from depot B to NW UGV stop
      is: 1589
2157 The UGV travel time between two UGV stops is: 1237
2158 [(0, 60), (0, 5926), (0, 5926), (0, 5926), (0, 5926
      ), (0, 5926), (0, 5926), (1589, 2789), (1589, 2789
      ), (1589, 2789), (1589, 2789), (1589, 2789), (1589
      , 2789), (4026, 4026), (4026, 4026), (4026, 4026
      ), (4026, 4026), (4026, 4026), (4026, 4026), (0,
      5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
      ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
      5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
      ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
      5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
      ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
      5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
      ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
      5926)]
2159 6977176.8180432785
2160 End node is [24]
2161 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
2162 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
2163 Objective: 30000000
2164 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
```

```

2164 16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33
      34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
      51 52 53 54
2165 55
2166 Route for vehicle 0:
2167 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
      Distance(0) -> 24 Fuel(287700) Time(0,0) Distance(0
      )
2168 Distance of the route: 0 ft
2169 Remaining Fuel of the route: 287700
2170 Total Time of the route: 0 seconds
2171
2172 Total Distance of all routes: 0 ft
2173 Total Fuel remaining of all routes: 287700
2174 Total Time of all routes: 0 seconds
2175 ***** Execute updated local
      optimization*****
2176 -----
      -----
2177 ***** UAV optimization via feedback
      solution*****
2178 -----
      -----
2179 Start point is: 5
2180 Parameters are: 7, 20, 0
2181 16
2182 31
2183 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
2184 (5.77, 5.83) (5.35, 6.1)
2185 10 10
2186 The travel time for UGV from depot B to NW UGV stop
      is: 1589
2187 The UGV travel time between two UGV stops is: 1237
2188 [(0, 60), (0, 5926), (0, 5926), (0, 5926), (0, 5926),
      (0, 5926), (0, 5926), (1589, 2789), (1589, 2789),
      (1589, 2789), (1589, 2789), (1589, 2789), (1589
      )

```

```
2188 , 2789), (4026, 4026), (4026, 4026), (4026, 4026)
    ), (4026, 4026), (4026, 4026), (4026, 4026), (0,
    5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
    ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
    5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
    ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
    5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
    ), (0, 5926), (0, 5926), (0, 5926), (0, 5926), (0,
    5926), (0, 5926), (0, 5926), (0, 5926), (0, 5926
    ), (0, 5926), (0, 5926), (0, 5926)]  
2189 6977176.8180432785  
2190 End node is [24]  
2191 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
2192 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]  
2193 Objective: 2560  
2194 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
    17 18 19 20 21 22  
2195 55  
2196 55  
2197 55  
2198 55  
2199 55  
2200 55  
2201 55  
2202 55  
2203 55  
2204 55  
2205 55  
2206 55  
2207 55  
2208 55  
2209 55  
2210 55  
2211 55  
2212 55  
2213 55  
2214 55  
2215 55
```

```
2216 55
2217 55
2218 55
2219 55
2220 55
2221 55
2222 55
2223 55
2224 55
2225 55
2226 55
2227 55
2228 Route for vehicle 0:
2229 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1197) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1222) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1247) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1272) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(947,1297) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(972,1322) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(997,1347) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1021,1371) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1046,1396) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1071,1421) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1096,1446) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 39 Fuel(64080) Time(1231,1471) Slack(0)
    FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258)
    Time(1400,1520) Slack(0) FuelSlack(0,0) Distance(
    38907) -> 12 Fuel(40422) Time(1589,1589) Slack(795
    ) FuelSlack(66101,66378) Distance(41213) -> 53 Fuel
    (261744) Time(2515,2515) Slack(0) FuelSlack(0,0)
```

```

2229 Distance(45539) -> 52 Fuel(244698) Time(2601,2601)
    Slack(0) FuelSlack(0,0) Distance(48380) -> 51 Fuel(
227886) Time(2685,2685) Slack(0) FuelSlack(0,0)
    Distance(51182) -> 50 Fuel(211050) Time(2770,2770)
    Slack(0) FuelSlack(0,0) Distance(53988) -> 49 Fuel(
194004) Time(2856,2856) Slack(0) FuelSlack(0,0)
    Distance(56829) -> 48 Fuel(177192) Time(2940,2940)
    Slack(0) FuelSlack(0,0) Distance(59631) -> 47 Fuel(
160356) Time(3025,3025) Slack(0) FuelSlack(0,0)
    Distance(62437) -> 46 Fuel(143310) Time(3111,3111)
    Slack(0) FuelSlack(0,0) Distance(65278) -> 45 Fuel(
126498) Time(3195,3195) Slack(0) FuelSlack(0,0)
    Distance(68080) -> 44 Fuel(109452) Time(3281,3281)
    Slack(0) FuelSlack(0,0) Distance(70921) -> 43 Fuel(
92850) Time(3364,3364) Slack(0) FuelSlack(0,0)
    Distance(73688) -> 42 Fuel(75804) Time(3450,3450)
    Slack(0) FuelSlack(0,0) Distance(76529) -> 41 Fuel(
58758) Time(3536,3536) Slack(0) FuelSlack(0,0)
    Distance(79370) -> 40 Fuel(42156) Time(3619,3619)
    Slack(0) FuelSlack(0,0) Distance(82137) -> 23 Fuel(
25110) Time(3705,3705) Slack(844) FuelSlack(25110,
287700) Distance(84978) -> 24 Fuel(287700) Time(
4549,4549) Distance(84978)
2230 Distance of the route: 84978 ft
2231 Remaining Fuel of the route: 287700
2232 Total Time of the route: 4549 seconds
2233
2234 Total Distance of all routes: 84978 ft
2235 Total Fuel remaining of all routes: 287700
2236 Total Time of all routes: 4549 seconds
2237 -----
-----  

2238 *****UAV optimization via feedback
solution*****
2239 -----
-----  

2240 Start point is: 5.577297210693359
2241 Parameters are: 7.103038787841797, 5, 5
2242 16
2243 31
2244 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (

```

```

2244 5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
, 6.26)]}
2245 (5.77, 5.83) (5.35, 6.1)
2246 10 10
2247 The travel time for UGV from depot B to NW UGV stop
is: 1589
2248 The UGV travel time between two UGV stops is: 1237
2249 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889
), (1589, 1889), (1589, 1889), (1589, 1889), (1589
, 1889), (3126, 3426), (3126, 3426), (3126, 3426
), (3126, 3426), (3126, 3426), (3126, 3426), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
2250 6857176.8180432785
2251 End node is [24]
2252 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
2253 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53, 54]
2254 Objective: 2488
2255 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
16 17 19 20 21 22 23
2256 55
2257 55
2258 55
2259 55
2260 55
2261 55
2262 55
2263 55

```

```
2264 55
2265 55
2266 55
2267 55
2268 55
2269 55
2270 55
2271 55
2272 55
2273 55
2274 55
2275 55
2276 55
2277 55
2278 55
2279 55
2280 55
2281 55
2282 55
2283 55
2284 55
2285 55
2286 55
2287 55
2288 Route for vehicle 0:
2289 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
```

```

2289 Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 47 Fuel(165660) Time(4505,4505) Slack(0)
    FuelSlack(0,0) Distance(60039) -> 46 Fuel(148614)
    Time(4591,4591) Slack(0) FuelSlack(0,0) Distance(
    62880) -> 45 Fuel(131802) Time(4675,4675) Slack(0)
    FuelSlack(0,0) Distance(65682) -> 44 Fuel(114756)
    Time(4761,4761) Slack(0) FuelSlack(0,0) Distance(
    68523) -> 43 Fuel(98154) Time(4844,4844) Slack(0)
    FuelSlack(0,0) Distance(71290) -> 42 Fuel(81108)
    Time(4930,4930) Slack(0) FuelSlack(0,0) Distance(
    74131) -> 41 Fuel(64062) Time(5016,5016) Slack(0)
    FuelSlack(0,0) Distance(76972) -> 40 Fuel(47460)
    Time(5099,5099) Slack(0) FuelSlack(0,0) Distance(
    79739) -> 24 Fuel(30414) Time(5185,5185) Distance(
    82580)

2290 Distance of the route: 82580 ft
2291 Remaining Fuel of the route: 30414
2292 Total Time of the route: 5185 seconds
2293
2294 Total Distance of all routes: 82580 ft
2295 Total Fuel remaining of all routes: 30414
2296 Total Time of all routes: 5185 seconds

```

```

2297 Local population: {(5, 15, 31, 5): 2782, (6, 16,
    16, 5): 2048, (7, 20, 0, 5): 1377, (7, 5, 5, 5):
    141}
2298 [1, 0, 0]
2299 Sorted idcs length is 3
2300 code switch length is 3
2301 Code switch addition: 1
2302 Sorted list is : [1]
2303 Code switch addition: 0
2304 Sorted list is : [1, 0]
2305 Code switch addition: 0
2306 Sorted list is : [1, 0, 0]
2307 {(7, 5, 5, 5): 141, (7, 20, 0, 5): 1377, (6, 16, 16
    , 5): 2048, (5, 15, 31, 5): 2782, (6, 50, 24, 3):
    7473, (2, 13, 40, 3): 7473, (7, 30, 31, 4): 6003045
    , (6, 20, 36, 4): 50000000, (4, 12, 21, 2):
    50000000, (4, 6, 50, 2): 50000000}
2308 -----
2309 UAV optimization via conventional feedforward
    solution
2310 -----
2311 Start point is: 5.0
2312 Parameters are: 7.0, 5.0, 5.0
2313 16
2314 31
2315 Candidate 1: [7, 5, 5, 5, 141]
2316 Candidate 2: [7, 20, 0, 5, 1377]
2317 Candidate 1: [7, 20, 0, 5, 1377]
2318 Candidate 2: [6, 20, 36, 4, 50000000]
2319 Father before deletion: [7, 5, 5, 5, 141]
2320 Mother before deletion: [7, 20, 0, 5, 1377]
2321 Father after deletion: [7, 5, 5, 5]
2322 Mother after deletion: [7, 20, 0, 5]
2323 00000111000001010000010100000101
2324 00000111000101000000000000000101
2325 Offspring1 after mutation:
    00000111000001010000010100000101
2326 Offspring2 after mutation:
    0000011100010100000001000000101
2327 32{2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1
    ), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)],
```

```

2327 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89
    ), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8
    : [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (
    5.35, 6.26)]}
2328 (5.77, 5.83) (5.35, 6.1)
2329 10 10
2330 The travel time for UGV from depot B to NW UGV stop
    is: 1589
2331 The UGV travel time between two UGV stops is: 1237
2332 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889
    ), (1589, 1889), (1589, 1889), (1589, 1889), (1589
    , 1889), (3126, 3426), (3126, 3426), (3126, 3426
    ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326)]
2333 6857176.8180432785
2334 End node is [24]
2335 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
2336 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]
2337 32
2338 [7, 5, 5, 5]
2339 [7, 20, 2, 5]
2340 Candidate 1: [6, 16, 16, 5, 2048]
2341 Candidate 2: [7, 5, 5, 5, 141]
2342 Candidate 1: [5, 15, 31, 5, 2782]
2343 Candidate 2: [4, 12, 21, 2, 50000000]
2344 Father before deletion: [7, 5, 5, 5, 141]
2345 Mother before deletion: [5, 15, 31, 5, 2782]
2346 Father after deletion: [7, 5, 5, 5]
2347 Mother after deletion: [5, 15, 31, 5]
2348 0000011100001010000010100000101

```

```
2349 00000101000011110001111100000101
2350 Offspring1 after mutation:
    00000101000011110001010100000101
2351 Offspring2 after mutation:
    00000111000001010000111100000101
2352 32 32
2353 [5, 15, 21, 5]
2354 [7, 5, 15, 5]
2355 Candidate 1: [6, 50, 24, 3, 7473]
2356 Candidate 2: [5, 15, 31, 5, 2782]
2357 Candidate 1: [2, 13, 40, 3, 7473]
2358 Candidate 2: [6, 50, 24, 3, 7473]
2359 Father before deletion: [5, 15, 31, 5, 2782]
2360 Mother before deletion: [2, 13, 40, 3, 7473]
2361 Father after deletion: [5, 15, 31, 5]
2362 Mother after deletion: [2, 13, 40, 3]
2363 00000101000011110001111100000101
2364 0000001000001101001010000000011
2365 Offspring1 after mutation:
    00000101000011110010100000000101
2366 Offspring2 after mutation:
    00000010000011010001111100000011
2367 32 32
2368 [5, 15, 40, 5]
2369 [2, 13, 31, 3]
2370 -----
2371 UAV optimization via conventional feedforward
    solution
2372 -----
2373 Start point is: 5
2374 Parameters are: 7, 5, 5
2375 16
2376 31
2377 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
2378 (5.77, 5.83) (5.35, 6.1)
2379 10 10
```

```
2380 The travel time for UGV from depot B to NW UGV stop  
is: 1589  
2381 The UGV travel time between two UGV stops is: 1237  
2382 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326),  
(0, 5326), (0, 5326), (1589, 1889), (1589, 1889),  
(1589, 1889), (1589, 1889), (1589, 1889), (1589,  
, 1889), (3126, 3426), (3126, 3426), (3126, 3426),  
(3126, 3426), (3126, 3426), (3126, 3426), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326), (0,  
5326), (0, 5326), (0, 5326), (0, 5326)]  
2383 6857176.8180432785  
2384 End node is [24]  
2385 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17, 18, 19, 20, 21, 22, 23]  
2386 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
50, 51, 52, 53, 54]  
2387 Objective: 8002624  
2388 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15  
16 17 19 20 21 22 23 40 41 42 43 44 45 46 47  
2389 55  
2390 55  
2391 55  
2392 55  
2393 55  
2394 55  
2395 55  
2396 55  
2397 55  
2398 55  
2399 55  
2400 55  
2401 55  
2402 55  
2403 55
```

```

2404 55
2405 55
2406 55
2407 55
2408 55
2409 55
2410 55
2411 55
2412 55
2413 Route for vehicle 0:
2414 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)

```

```
2414 FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)
2415 Distance of the route: 86983 ft
2416 Remaining Fuel of the route: 3996
2417 Total Time of the route: 5321 seconds
2418
2419 Total Distance of all routes: 86983 ft
2420 Total Fuel remaining of all routes: 3996
2421 Total Time of all routes: 5321 seconds
2422 Objective value is: 8002624
2423 -----
2424 UAV optimization via conventional feedforward
    solution
2425 -----
2426 Start point is: 5.0
2427 Parameters are: 7.3500000000000005, 5.0, 5.0
2428 16
2429 31
2430 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
2431 (5.77, 5.83) (5.35, 6.1)
2432 10 10
2433 The travel time for UGV from depot B to NW UGV stop
    is: 1589
2434 The UGV travel time between two UGV stops is: 1237
2435 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326),
    ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889),
    ), (1589, 1889), (1589, 1889), (1589, 1889), (1589
    , 1889), (3126, 3426), (3126, 3426), (3126, 3426),
    ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326),
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
```

```
2435 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326)
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
2436 6857176.8180432785
2437 End node is [24]
2438 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
2439 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]
2440 Objective: 8002624
2441 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
2442 55
2443 55
2444 55
2445 55
2446 55
2447 55
2448 55
2449 55
2450 55
2451 55
2452 55
2453 55
2454 55
2455 55
2456 55
2457 55
2458 55
2459 55
2460 55
2461 55
2462 55
2463 55
2464 55
2465 55
2466 Route for vehicle 0:
```

```

2467 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
      72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
      129384) Time(930,978) Slack(72) FuelSlack(0,0)
      Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
      Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
      (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
      Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
      Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
      (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
      Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
      Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
      (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
      Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
      Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
      (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
      Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
      Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
      (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
      Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
      Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
      (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
      Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
      Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
      (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
      Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
      Slack(765) FuelSlack(70127,70158) Distance(39699
      ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
      FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
      Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
      45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
      FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
      Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
      51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
      FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
      Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
      57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
      86983)

2468 Distance of the route: 86983 ft
2469 Remaining Fuel of the route: 3996
2470 Total Time of the route: 5321 seconds

```



```
2491 , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
2492 Objective: 8002624
2493 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
2494 55
2495 55
2496 55
2497 55
2498 55
2499 55
2500 55
2501 55
2502 55
2503 55
2504 55
2505 55
2506 55
2507 55
2508 55
2509 55
2510 55
2511 55
2512 55
2513 55
2514 55
2515 55
2516 55
2517 55
2518 Route for vehicle 0:
2519 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
      72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
      129384) Time(930,978) Slack(72) FuelSlack(0,0)
      Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
      Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
      (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
      Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
      Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
      (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
      Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
```

```

2519 Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

2520 Distance of the route: 86983 ft
2521 Remaining Fuel of the route: 3996
2522 Total Time of the route: 5321 seconds
2523
2524 Total Distance of all routes: 86983 ft
2525 Total Fuel remaining of all routes: 3996
2526 Total Time of all routes: 5321 seconds
2527 Objective value is: 8002624
2528 -----
2529 UAV optimization via conventional feedforward
    solution
2530 -----
2531 Start point is: 5.0
2532 Parameters are: 7.0, 5.25, 5.0

```



```
2570 7121176.818043279
2571 End node is [24]
2572 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
2573 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]
2574 Objective: 8002624
2575 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
2576 55
2577 55
2578 55
2579 55
2580 55
2581 55
2582 55
2583 55
2584 55
2585 55
2586 55
2587 55
2588 55
2589 55
2590 55
2591 55
2592 55
2593 55
2594 55
2595 55
2596 55
2597 55
2598 55
2599 55
2600 Route for vehicle 0:
2601 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
```

```

2601 (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)
2602 Distance of the route: 86983 ft
2603 Remaining Fuel of the route: 3996
2604 Total Time of the route: 5321 seconds
2605
2606 Total Distance of all routes: 86983 ft
2607 Total Fuel remaining of all routes: 3996
2608 Total Time of all routes: 5321 seconds
2609 Objective value is: 8002624
2610 -----

```

```
2611 UAV optimization via conventional feedforward  
      solution  
2612 -----  
2613 Start point is: 5.0  
2614 Parameters are: 7.0, 5.0, 5.25  
2615 16  
2616 31  
2617 Objective: 4097  
2618 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
      17 18 19 20 21 22  
2619 55  
2620 55  
2621 55  
2622 55  
2623 55  
2624 55  
2625 55  
2626 55  
2627 55  
2628 55  
2629 55  
2630 55  
2631 55  
2632 55  
2633 55  
2634 55  
2635 55  
2636 55  
2637 55  
2638 55  
2639 55  
2640 55  
2641 55  
2642 55  
2643 55  
2644 55  
2645 55  
2646 55  
2647 55  
2648 55  
2649 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
```

```

2649 5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
, 6.26)]}
2650 (5.77, 5.83) (5.35, 6.1)
2651 10 10
2652 The travel time for UGV from depot B to NW UGV stop
is: 1589
2653 The UGV travel time between two UGV stops is: 1237
2654 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889
), (1589, 1889), (1589, 1889), (1589, 1889), (1589
, 1889), (3126, 3426), (3126, 3426), (3126, 3426
), (3126, 3426), (3126, 3426), (3126, 3426), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
2655 6857176.8180432785
2656 End node is [24]
2657 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
2658 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53, 54]
2659 55
2660 55
2661 55
2662 Route for vehicle 0:
2663 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
Time(847,1267) Slack(0) FuelSlack(0,0) Distance(

```

2663	28024)	-> 29 Fuel(114486) Time(872,1373) Slack(0)
	FuelSlack(0,0) Distance(28869)	-> 30 Fuel(109410)
	Time(897,1398) Slack(0) FuelSlack(0,0) Distance(
	29715)	-> 31 Fuel(104340) Time(922,1423) Slack(0)
	FuelSlack(0,0) Distance(30560)	-> 32 Fuel(99270)
	Time(947,1448) Slack(0) FuelSlack(0,0) Distance(
	31405)	-> 33 Fuel(94194) Time(972,1473) Slack(0)
	FuelSlack(0,0) Distance(32251)	-> 34 Fuel(89124)
	Time(997,1498) Slack(0) FuelSlack(0,0) Distance(
	33096)	-> 35 Fuel(84372) Time(1021,1522) Slack(0)
	FuelSlack(0,0) Distance(33888)	-> 36 Fuel(79296)
	Time(1046,1547) Slack(0) FuelSlack(0,0) Distance(
	34734)	-> 37 Fuel(74226) Time(1092,1572) Slack(0)
	FuelSlack(0,0) Distance(35579)	-> 38 Fuel(69156)
	Time(1237,1597) Slack(0) FuelSlack(0,0) Distance(
	36424)	-> 39 Fuel(64080) Time(1382,1622) Slack(0)
	FuelSlack(0,0) Distance(37270)	-> 54 Fuel(54258)
	Time(1551,1671) Slack(0) FuelSlack(0,0) Distance(
	38907)	-> 12 Fuel(47340) Time(1705,1705) Slack(772)
) FuelSlack(68052,68094) Distance(40060)	-> 53 Fuel(266946) Time(2581,2581) Slack(0) FuelSlack(0,0)
	Distance(43519)	-> 52 Fuel(249900) Time(2667,2667)
	Slack(0) FuelSlack(0,0) Distance(46360)	-> 51 Fuel(233088) Time(2751,2751) Slack(0) FuelSlack(0,0)
	Distance(49162)	-> 50 Fuel(216252) Time(2836,2836)
	Slack(0) FuelSlack(0,0) Distance(51968)	-> 49 Fuel(199206) Time(2922,2922) Slack(0) FuelSlack(0,0)
	Distance(54809)	-> 48 Fuel(182394) Time(3006,3006)
	Slack(0) FuelSlack(0,0) Distance(57611)	-> 47 Fuel(165558) Time(3091,3091) Slack(0) FuelSlack(0,0)
	Distance(60417)	-> 46 Fuel(148512) Time(3177,3177)
	Slack(0) FuelSlack(0,0) Distance(63258)	-> 45 Fuel(131700) Time(3261,3261) Slack(0) FuelSlack(0,0)
	Distance(66060)	-> 44 Fuel(114654) Time(3347,3347)
	Slack(0) FuelSlack(0,0) Distance(68901)	-> 43 Fuel(98052) Time(3430,3430) Slack(0) FuelSlack(0,0)
	Distance(71668)	-> 42 Fuel(81006) Time(3516,3516)
	Slack(0) FuelSlack(0,0) Distance(74509)	-> 41 Fuel(63960) Time(3602,3602) Slack(0) FuelSlack(0,0)
	Distance(77350)	-> 40 Fuel(47358) Time(3685,3685)
	Slack(0) FuelSlack(0,0) Distance(80117)	-> 23 Fuel(

```
2663 30312) Time(3771,3771) Slack(827) FuelSlack(30312,  
287700) Distance(82958) -> 24 Fuel(287700) Time(  
6197,6197) Distance(135757)  
2664 Distance of the route: 135757 ft  
2665 Remaining Fuel of the route: 287700  
2666 Total Time of the route: 6197 seconds  
2667  
2668 Total Distance of all routes: 135757 ft  
2669 Total Fuel remaining of all routes: 287700  
2670 Total Time of all routes: 6197 seconds  
2671 *****Execute updated global  
optimization*****  
2672 -----  
-----  
2673 *****UAV optimization via feedback  
solution*****  
2674 -----  
-----  
2675 Start point is: 5  
2676 Parameters are: 6, 16, 16  
2677 16  
2678 31  
2679 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}  
2680 (5.56, 5.89) (5.35, 6.1)  
2681 10 10  
2682 The travel time for UGV from depot B to NW UGV stop  
is: 1705  
2683 The UGV travel time between two UGV stops is: 1121  
2684 [(0, 60), (0, 6646), (0, 6646), (0, 6646), (0, 6646),  
(0, 6646), (0, 6646), (1705, 2665), (1705, 2665),  
(1705, 2665), (1705, 2665), (1705, 2665), (1705,  
2665), (3786, 4746), (3786, 4746), (3786, 4746),  
(3786, 4746), (3786, 4746), (3786, 4746), (0,  
6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),  
(0, 6646), (0, 6646), (0, 6646), (0, 6646), (0,  
6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646)
```

```
2684 ), (0, 6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),
       (0, 6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),
       (0, 6646), (0, 6646), (0, 6646), (0, 6646), (0, 6646),
       (0, 6646), (0, 6646), (0, 6646), (0, 6646)]
2685 7121176.818043279
2686 End node is [24]
2687 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
2688 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
2689 Objective: 8002624
2690 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
2691 55
2692 55
2693 55
2694 55
2695 55
2696 55
2697 55
2698 55
2699 55
2700 55
2701 55
2702 55
2703 55
2704 55
2705 55
2706 55
2707 55
2708 55
2709 55
2710 55
2711 55
2712 55
2713 55
2714 55
2715 Route for vehicle 0:
2716 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
```

```

2716 Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel(
    119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel(
    109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel(
    99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel(
    89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel(
    79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel(
    69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel(
    54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)
2717 Distance of the route: 86983 ft
2718 Remaining Fuel of the route: 3996
2719 Total Time of the route: 5321 seconds
2720

```



```
2741 , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
2742 Objective: 2498
2743 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
      17 18 19 20 21 22
2744 55
2745 55
2746 55
2747 55
2748 55
2749 55
2750 55
2751 55
2752 55
2753 55
2754 55
2755 55
2756 55
2757 55
2758 55
2759 55
2760 55
2761 55
2762 55
2763 55
2764 55
2765 55
2766 55
2767 55
2768 55
2769 55
2770 55
2771 55
2772 55
2773 55
2774 55
2775 55
2776 55
2777 Route for vehicle 0:
2778 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
```

2778	0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)) Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386) -> 27 Fuel(124308) Time(823,1123) Slack(0) FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556) Time(847,1267) Slack(0) FuelSlack(0,0) Distance(28024) -> 29 Fuel(114486) Time(872,1373) Slack(0) FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410) Time(897,1398) Slack(0) FuelSlack(0,0) Distance(29715) -> 31 Fuel(104340) Time(922,1423) Slack(0) FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270) Time(947,1448) Slack(0) FuelSlack(0,0) Distance(31405) -> 33 Fuel(94194) Time(972,1473) Slack(0) FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124) Time(997,1498) Slack(0) FuelSlack(0,0) Distance(33096) -> 35 Fuel(84372) Time(1021,1522) Slack(0) FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296) Time(1046,1547) Slack(0) FuelSlack(0,0) Distance(34734) -> 37 Fuel(74226) Time(1092,1572) Slack(0) FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156) Time(1237,1597) Slack(0) FuelSlack(0,0) Distance(36424) -> 39 Fuel(64080) Time(1382,1622) Slack(0) FuelSlack(0,0) Distance(37270) -> 54 Fuel(54258) Time(1551,1671) Slack(0) FuelSlack(0,0) Distance(38907) -> 12 Fuel(47340) Time(1705,1705) Slack(772)) FuelSlack(68052,68094) Distance(40060) -> 53 Fuel (266946) Time(2581,2581) Slack(0) FuelSlack(0,0) Distance(43519) -> 52 Fuel(249900) Time(2667,2667) Slack(0) FuelSlack(0,0) Distance(46360) -> 51 Fuel(233088) Time(2751,2751) Slack(0) FuelSlack(0,0) Distance(49162) -> 50 Fuel(216252) Time(2836,2836) Slack(0) FuelSlack(0,0) Distance(51968) -> 49 Fuel(199206) Time(2922,2922) Slack(0) FuelSlack(0,0) Distance(54809) -> 48 Fuel(182394) Time(3006,3006) Slack(0) FuelSlack(0,0) Distance(57611) -> 47 Fuel(165558) Time(3091,3091) Slack(0) FuelSlack(0,0) Distance(60417) -> 46 Fuel(148512) Time(3177,3177) Slack(0) FuelSlack(0,0) Distance(63258) -> 45 Fuel(131700) Time(3261,3261) Slack(0) FuelSlack(0,0) Distance(66060) -> 44 Fuel(114654) Time(3347,3347) Slack(0) FuelSlack(0,0) Distance(68901) -> 43 Fuel(98052) Time(3430,3430) Slack(0) FuelSlack(0,0)
------	---

```
2778 Distance(71668) -> 42 Fuel(81006) Time(3516,3516)
    Slack(0) FuelSlack(0,0) Distance(74509) -> 41 Fuel(
    63960) Time(3602,3602) Slack(0) FuelSlack(0,0)
    Distance(77350) -> 40 Fuel(47358) Time(3685,3685)
    Slack(0) FuelSlack(0,0) Distance(80117) -> 23 Fuel(
    30312) Time(3771,3771) Slack(827) FuelSlack(30312,
    287700) Distance(82958) -> 24 Fuel(287700) Time(
    4598,4598) Distance(82958)
2779 Distance of the route: 82958 ft
2780 Remaining Fuel of the route: 287700
2781 Total Time of the route: 4598 seconds
2782
2783 Total Distance of all routes: 82958 ft
2784 Total Fuel remaining of all routes: 287700
2785 Total Time of all routes: 4598 seconds
2786 Global population dict is: {(6, 16, 16, 5): 2048}
2787 -----
2788 UAV optimization via conventional feedforward
    solution
2789 -----
2790 Start point is: 5
2791 Parameters are: 5, 15, 31
2792 16
2793 31
2794 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
2795 (5.35, 6.26) (5.77, 5.83)
2796 10 10
2797 The travel time for UGV from depot B to NW UGV stop
    is: 1980
2798 The UGV travel time between two UGV stops is: 1322
2799 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651), (1980, 2880), (1980, 2880
    ), (1980, 2880), (1980, 2880), (1980, 2880), (1980
    , 2880), (4202, 6062), (4202, 6062), (4202, 6062
    ), (4202, 6062), (4202, 6062), (4202, 6062), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651)
```

```
2799 ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
    7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
    (0, 7651), (0, 7651), (0, 7651), (0, 7651)]  
2800 7581712.12724779  
2801 End node is [24]  
2802 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
2803 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53]  
2804 Objective: 8002624  
2805 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 19 20 21 22 23 40 41 42 43 44 45 46 47  
2806 55  
2807 55  
2808 55  
2809 55  
2810 55  
2811 55  
2812 55  
2813 55  
2814 55  
2815 55  
2816 55  
2817 55  
2818 55  
2819 55  
2820 55  
2821 55  
2822 55  
2823 55  
2824 55  
2825 55  
2826 55  
2827 55  
2828 55  
2829 55
```

2830 Route for vehicle 0:

2831 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
 Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(72) FuelSlack(0,0)
 Distance(25541) -> 26 Fuel(129384) Time(930,978) Slack(72) FuelSlack(0,0)
 Distance(26386) -> 27 Fuel(124308) Time(1075,1123) Slack(72) FuelSlack(0,0)
 Distance(27232) -> 28 Fuel(119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
 Distance(28024) -> 29 Fuel(114486) Time(1364,1412) Slack(72) FuelSlack(0,0)
 Distance(28869) -> 30 Fuel(109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
 Distance(29715) -> 31 Fuel(104340) Time(1654,1702) Slack(72) FuelSlack(0,0)
 Distance(30560) -> 32 Fuel(99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
 Distance(31405) -> 33 Fuel(94194) Time(1944,1992) Slack(72) FuelSlack(0,0)
 Distance(32251) -> 34 Fuel(89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
 Distance(33096) -> 35 Fuel(84372) Time(2233,2281) Slack(72) FuelSlack(0,0)
 Distance(33888) -> 36 Fuel(79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
 Distance(34734) -> 37 Fuel(74226) Time(2523,2571) Slack(72) FuelSlack(0,0)
 Distance(35579) -> 38 Fuel(69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
 Distance(36424) -> 39 Fuel(64080) Time(2813,2861) Slack(72) FuelSlack(0,0)
 Distance(37270) -> 54 Fuel(54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
 Distance(38907) -> 18 Fuel(49506) Time(3126,3126) Slack(765) FuelSlack(70127,70158)
 Distance(39699) -> 53 Fuel(267048) Time(3995,3995) Slack(0) FuelSlack(0,0)
 Distance(43141) -> 52 Fuel(250002) Time(4081,4081) Slack(0) FuelSlack(0,0)
 Distance(45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0) FuelSlack(0,0)
 Distance(48784) -> 50 Fuel(216354) Time(4250,4250) Slack(0) FuelSlack(0,0)
 Distance(51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0) FuelSlack(0,0)
 Distance(54431) -> 48 Fuel(182496) Time(4420,4420) Slack(0) FuelSlack(0,0)
 Distance(57233) -> 24 Fuel(3996) Time(5321,5321) Distance(86983)

2832 Distance of the route: 86983 ft
 2833 Remaining Fuel of the route: 3996


```
2855 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
2856 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
2857
2858 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
      17 18 19 20 21 22
2859 54
2860 54
2861 54
2862 54
2863 54
2864 54
2865 54
2866 54
2867 54
2868 54
2869 54
2870 54
2871 54
2872 54
2873 54
2874 54
2875 54
2876 54
2877 54
2878 54
2879 54
2880 54
2881 54
2882 54
2883 54
2884 54
2885 54
2886 54
2887 54
2888 54
2889 54
2890 54
2891 Route for vehicle 0:
```

```

2892 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
    (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
    Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
    243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
    Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
    Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
    210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
    Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
    Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
    176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
    Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
    Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
    142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
    Distance(61452) -> 44 Fuel(125796) Time(3513,3513)
    Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)

```

```
2892 Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(75102) Time(3768,3768) Slack(0) FuelSlack(0,0) Distance(72703) -> 40 Fuel(58056) Time(3854,3854) Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(41454) Time(3937,3937) Slack(0) FuelSlack(0,0) Distance(78311) -> 23 Fuel(24408) Time(4023,4023) Slack(846) FuelSlack(24408,287700) Distance(81152) -> 24 Fuel(287700) Time(6468,6468) Distance(133951)
2893 Distance of the route: 133951 ft
2894 Remaining Fuel of the route: 287700
2895 Total Time of the route: 6468 seconds
2896
2897 Total Distance of all routes: 133951 ft
2898 Total Fuel remaining of all routes: 287700
2899 Total Time of all routes: 6468 seconds
2900 *****Execute updated global optimization*****
2901 -----
-----  
2902 *****UAV optimization via feedback solution*****
2903 -----
-----  
2904 Start point is: 5
2905 Parameters are: 5, 15, 31
2906 16
2907 31
2908 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
2909 (5.35, 6.26) (5.77, 5.83)
2910 10 10
2911 The travel time for UGV from depot B to NW UGV stop is: 1980
2912 The UGV travel time between two UGV stops is: 1322
2913 [(0, 60), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (1980, 2880), (1980, 2880)
```

```
2913 ), (1980, 2880), (1980, 2880), (1980, 2880),
     , 2880), (4202, 6062), (4202, 6062), (4202, 6062),
     ), (4202, 6062), (4202, 6062), (4202, 6062), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     ), (0, 7651), (0, 7651), (0, 7651), (0, 7651), (0,
     7651), (0, 7651), (0, 7651), (0, 7651), (0, 7651),
     ), (0, 7651), (0, 7651), (0, 7651)]  
2914 7581712.12724779  
2915 End node is [24]  
2916 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
     15, 16, 17, 18, 19, 20, 21, 22, 23]  
2917 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
     , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
     50, 51, 52, 53]  
2918 Objective: 8002624  
2919 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
     16 17 19 20 21 22 23 40 41 42 43 44 45 46 47  
2920 55  
2921 55  
2922 55  
2923 55  
2924 55  
2925 55  
2926 55  
2927 55  
2928 55  
2929 55  
2930 55  
2931 55  
2932 55  
2933 55  
2934 55  
2935 55  
2936 55  
2937 55  
2938 55  
2939 55
```

```
2940 55
2941 55
2942 55
2943 55
2944 Route for vehicle 0:
2945 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
```



```
2966 ), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]  
2967 6857176.8180432785  
2968 End node is [24]  
2969 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
2970 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
    50, 51, 52, 53, 54]  
2971 Objective: 2445  
2972 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16  
    17 18 19 20 21 22  
2973 54  
2974 54  
2975 54  
2976 54  
2977 54  
2978 54  
2979 54  
2980 54  
2981 54  
2982 54  
2983 54  
2984 54  
2985 54  
2986 54  
2987 54  
2988 54  
2989 54  
2990 54  
2991 54  
2992 54  
2993 54  
2994 54  
2995 54  
2996 54  
2997 54  
2998 54  
2999 54  
3000 54  
3001 54  
3002 54
```

```

3003 54
3004 54
3005 Route for vehicle 0:
3006 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
  Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(0)
  FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)
  ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
  26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
  FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
  Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
  28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
  FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
  Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
  29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
  FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
  Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
  31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
  FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
  Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
  33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
  FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
  Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
  34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
  FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
  Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
  36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)
  ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(
  277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
  Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
  Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(
  243996) Time(2919,2919) Slack(0) FuelSlack(0,0)
  Distance(44554) -> 50 Fuel(227184) Time(3003,3003)
  Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(
  210348) Time(3088,3088) Slack(0) FuelSlack(0,0)
  Distance(50162) -> 48 Fuel(193302) Time(3174,3174)
  Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(
  176490) Time(3258,3258) Slack(0) FuelSlack(0,0)
  Distance(55805) -> 46 Fuel(159654) Time(3343,3343)
  Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(
  142608) Time(3429,3429) Slack(0) FuelSlack(0,0)
  Distance(61452) -> 44 Fuel(125796) Time(3513,3513)

```

```

3006 Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(
    108750) Time(3599,3599) Slack(0) FuelSlack(0,0)
    Distance(67095) -> 42 Fuel(92148) Time(3682,3682)
    Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(
    75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
    Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
)

3007 Distance of the route: 81152 ft
3008 Remaining Fuel of the route: 287700
3009 Total Time of the route: 4869 seconds
3010
3011 Total Distance of all routes: 81152 ft
3012 Total Fuel remaining of all routes: 287700
3013 Total Time of all routes: 4869 seconds
3014 Global population dict is: {(6, 16, 16, 5): 2048, (
    5, 15, 31, 5): 2782}
3015 -----
3016 UAV optimization via conventional feedforward
    solution
3017 -----
3018 Start point is: 5
3019 Parameters are: 7, 5, 5
3020 16
3021 31
3022 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
3023 (5.77, 5.83) (5.35, 6.1)
3024 10 10
3025 The travel time for UGV from depot B to NW UGV stop
    is: 1589
3026 The UGV travel time between two UGV stops is: 1237
3027 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326)
]

```

```
3027 ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889)
    ), (1589, 1889), (1589, 1889), (1589, 1889), (1589
    , 1889), (3126, 3426), (3126, 3426), (3126, 3426
    ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0,
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326)]  
3028 6857176.8180432785  
3029 End node is [24]  
3030 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]  
3031 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]  
3032 Objective: 8002624  
3033 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 19 20 21 22 23 40 41 42 43 44 45 46 47  
3034 55  
3035 55  
3036 55  
3037 55  
3038 55  
3039 55  
3040 55  
3041 55  
3042 55  
3043 55  
3044 55  
3045 55  
3046 55  
3047 55  
3048 55  
3049 55  
3050 55  
3051 55  
3052 55
```

```
3053 55
3054 55
3055 55
3056 55
3057 55
3058 Route for vehicle 0:
3059 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
129384) Time(930,978) Slack(72) FuelSlack(0,0)
Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
(119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
(109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
(99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
(89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
(79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
(69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
(54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
Slack(765) FuelSlack(70127,70158) Distance(39699
) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
```

```
3059 Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)
3060 Distance of the route: 86983 ft
3061 Remaining Fuel of the route: 3996
3062 Total Time of the route: 5321 seconds
3063
3064 Total Distance of all routes: 86983 ft
3065 Total Fuel remaining of all routes: 3996
3066 Total Time of all routes: 5321 seconds
3067 Objective value is: 8002624
3068 -----
3069 UAV optimization via conventional feedforward
    solution
3070 -----
3071 Start point is: 5.0
3072 Parameters are: 7.175000000000001, 5.0, 5.0
3073 16
3074 31
3075 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
3076 (5.77, 5.83) (5.35, 6.1)
3077 10 10
3078 The travel time for UGV from depot B to NW UGV stop
    is: 1589
3079 The UGV travel time between two UGV stops is: 1237
3080 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889
    ), (1589, 1889), (1589, 1889), (1589, 1889), (1589
    , 1889), (3126, 3426), (3126, 3426), (3126, 3426
    ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
    5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
```

```
3080 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326)
    ), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
3081 6857176.8180432785
3082 End node is [24]
3083 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
    15, 16, 17, 18, 19, 20, 21, 22, 23]
3084 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
    , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
    50, 51, 52, 53, 54]
3085 Objective: 8002624
3086 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
    16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
3087 55
3088 55
3089 55
3090 55
3091 55
3092 55
3093 55
3094 55
3095 55
3096 55
3097 55
3098 55
3099 55
3100 55
3101 55
3102 55
3103 55
3104 55
3105 55
3106 55
3107 55
3108 55
3109 55
3110 55
3111 Route for vehicle 0:
3112 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
```

```

3112 Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3113 Distance of the route: 86983 ft
3114 Remaining Fuel of the route: 3996
3115 Total Time of the route: 5321 seconds
3116
3117 Total Distance of all routes: 86983 ft
3118 Total Fuel remaining of all routes: 3996
3119 Total Time of all routes: 5321 seconds

```

```
3120 -----
3121 UAV optimization via conventional feedforward
      solution
3122 -----
3123 Start point is: 5
3124 Parameters are: 7, 20, 2
3125 16
3126 31
3127 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
3128 (5.77, 5.83) (5.35, 6.1)
3129 10 10
3130 The travel time for UGV from depot B to NW UGV stop
      is: 1589
3131 The UGV travel time between two UGV stops is: 1237
3132 [(0, 60), (0, 6046), (0, 6046), (0, 6046), (0, 6046
      ), (0, 6046), (0, 6046), (1589, 2789), (1589, 2789
      ), (1589, 2789), (1589, 2789), (1589, 2789), (1589
      , 2789), (4026, 4146), (4026, 4146), (4026, 4146
      ), (4026, 4146), (4026, 4146), (4026, 4146), (0,
      6046), (0, 6046), (0, 6046), (0, 6046), (0, 6046
      ), (0, 6046), (0, 6046), (0, 6046), (0, 6046), (0,
      6046), (0, 6046), (0, 6046), (0, 6046), (0, 6046
      ), (0, 6046), (0, 6046), (0, 6046), (0, 6046), (0,
      6046), (0, 6046), (0, 6046), (0, 6046), (0, 6046
      ), (0, 6046), (0, 6046), (0, 6046), (0, 6046), (0,
      6046), (0, 6046), (0, 6046), (0, 6046), (0, 6046
      ), (0, 6046), (0, 6046), (0, 6046), (0, 6046), (0,
      6046)]
3133 7001176.8180432785
3134 End node is [24]
3135 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
3136 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
3137 Objective: 8002624
3138 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
```

```
3138 16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
3139 55
3140 55
3141 55
3142 55
3143 55
3144 55
3145 55
3146 55
3147 55
3148 55
3149 55
3150 55
3151 55
3152 55
3153 55
3154 55
3155 55
3156 55
3157 55
3158 55
3159 55
3160 55
3161 55
3162 55
3163 Route for vehicle 0:
3164 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel(
    119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel(
    109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel(
    99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
```

```

3164 (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3165 Distance of the route: 86983 ft
3166 Remaining Fuel of the route: 3996
3167 Total Time of the route: 5321 seconds
3168
3169 Total Distance of all routes: 86983 ft
3170 Total Fuel remaining of all routes: 3996
3171 Total Time of all routes: 5321 seconds
3172 Objective value is: 8002624
3173 -----
3174 UAV optimization via conventional feedforward
    solution
3175 -----
3176 Start point is: 5.0
3177 Parameters are: 7.0, 5.125, 5.0
3178 16
3179 31
3180 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5

```

```

3180 : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
3181 (5.77, 5.83) (5.35, 6.1)
3182 10 10
3183 The travel time for UGV from depot B to NW UGV stop is: 1589
3184 The UGV travel time between two UGV stops is: 1237
3185 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889), (1589, 1889), (1589, 1889), (1589, 1889), (1589, 1889), (1589, 1889), (3126, 3426), (3126, 3426), (3126, 3426), (3126, 3426), (3126, 3426), (3126, 3426), (3126, 3426), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
3186 6857176.8180432785
3187 End node is [24]
3188 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23]
3189 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54]
3190 Objective: 30000000
3191 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54
3192 55
3193 Route for vehicle 0:
3194 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0) Distance(0) -> 24 Fuel(287700) Time(0,0) Distance(0)
3195 Distance of the route: 0 ft
3196 Remaining Fuel of the route: 287700

```



```
3218 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53]
3219 Objective: 8002624
3220 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
                  16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
3221 55
3222 55
3223 55
3224 55
3225 55
3226 55
3227 55
3228 55
3229 55
3230 55
3231 55
3232 55
3233 55
3234 55
3235 55
3236 55
3237 55
3238 55
3239 55
3240 55
3241 55
3242 55
3243 55
3244 55
3245 Route for vehicle 0:
3246 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
      72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
      129384) Time(930,978) Slack(72) FuelSlack(0,0)
      Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
      Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel(
      119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
      Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
      Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel(
      109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
```

```
3246 Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3247 Distance of the route: 86983 ft
3248 Remaining Fuel of the route: 3996
3249 Total Time of the route: 5321 seconds
3250
3251 Total Distance of all routes: 86983 ft
3252 Total Fuel remaining of all routes: 3996
3253 Total Time of all routes: 5321 seconds
3254 Objective value is: 8002624
3255 -----
3256 UAV optimization via conventional feedforward
    solution
3257 -----
3258 Start point is: 5.0
```

```
3259 Parameters are: 7.0, 5.0, 5.125
3260 16
3261 31
3262 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
3263 (5.77, 5.83) (5.35, 6.1)
3264 10 10
3265 The travel time for UGV from depot B to NW UGV stop
is: 1589
3266 The UGV travel time between two UGV stops is: 1237
3267 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326),
(0, 5326), (0, 5326), (1589, 1889), (1589, 1889),
(1589, 1889), (1589, 1889), (1589, 1889), (1589,
1889), (3126, 3426), (3126, 3426), (3126, 3426),
(3126, 3426), (3126, 3426), (3126, 3426), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326)]
3268 6857176.8180432785
3269 End node is [24]
3270 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
3271 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53, 54]
3272 Objective: 4044
3273 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22
3274 54
3275 54
3276 54
3277 54
```

```
3278 54
3279 54
3280 54
3281 54
3282 54
3283 54
3284 54
3285 54
3286 54
3287 54
3288 54
3289 54
3290 54
3291 54
3292 54
3293 54
3294 54
3295 54
3296 54
3297 54
3298 54
3299 54
3300 54
3301 54
3302 54
3303 54
3304 54
3305 54
3306 Route for vehicle 0:
3307 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
```

3307 Time(966,1806) Slack(0) FuelSlack(0,0) Distance(31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0) FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124) Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0) FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296) Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0) FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156) Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(277878) Time(2748,2748) Slack(0) FuelSlack(0,0) Distance(38907) -> 52 Fuel(261042) Time(2833,2833) Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(243996) Time(2919,2919) Slack(0) FuelSlack(0,0) Distance(44554) -> 50 Fuel(227184) Time(3003,3003) Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(210348) Time(3088,3088) Slack(0) FuelSlack(0,0) Distance(50162) -> 48 Fuel(193302) Time(3174,3174) Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(176490) Time(3258,3258) Slack(0) FuelSlack(0,0) Distance(55805) -> 46 Fuel(159654) Time(3343,3343) Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(142608) Time(3429,3429) Slack(0) FuelSlack(0,0) Distance(61452) -> 44 Fuel(125796) Time(3513,3513) Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(108750) Time(3599,3599) Slack(0) FuelSlack(0,0) Distance(67095) -> 42 Fuel(92148) Time(3682,3682) Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(75102) Time(3768,3768) Slack(0) FuelSlack(0,0) Distance(72703) -> 40 Fuel(58056) Time(3854,3854) Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(41454) Time(3937,3937) Slack(0) FuelSlack(0,0) Distance(78311) -> 23 Fuel(24408) Time(4023,4023) Slack(846) FuelSlack(24408,287700) Distance(81152) -> 24 Fuel(287700) Time(6468,6468) Distance(133951)

3308 Distance of the route: 133951 ft

3309 Remaining Fuel of the route: 287700

3310 Total Time of the route: 6468 seconds


```
3330 End node is [24]
3331 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
3332 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53]
3333 Objective: 8002624
3334 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
3335 55
3336 55
3337 55
3338 55
3339 55
3340 55
3341 55
3342 55
3343 55
3344 55
3345 55
3346 55
3347 55
3348 55
3349 55
3350 55
3351 55
3352 55
3353 55
3354 55
3355 55
3356 55
3357 55
3358 55
3359 Route for vehicle 0:
3360 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
      72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
      129384) Time(930,978) Slack(72) FuelSlack(0,0)
      Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
      Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
      (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
```

```

3360 Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3361 Distance of the route: 86983 ft
3362 Remaining Fuel of the route: 3996
3363 Total Time of the route: 5321 seconds
3364
3365 Total Distance of all routes: 86983 ft
3366 Total Fuel remaining of all routes: 3996
3367 Total Time of all routes: 5321 seconds
3368 Objective value is: 8002624
3369 -----
3370 UAV optimization via conventional feedforward

```

```
3370 solution
3371 -----
3372 Start point is: 5.125
3373 Parameters are: 7.0, 5.0, 5.0
3374 16
3375 31
3376 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5: [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5.56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35, 6.26)]}
3377 (5.77, 5.83) (5.35, 6.1)
3378 10 10
3379 The travel time for UGV from depot B to NW UGV stop
is: 1589
3380 The UGV travel time between two UGV stops is: 1237
3381 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326),
(0, 5326), (0, 5326), (1589, 1889), (1589, 1889),
(1589, 1889), (1589, 1889), (1589, 1889), (1589,
1889), (3126, 3426), (3126, 3426), (3126, 3426),
(3126, 3426), (3126, 3426), (3126, 3426), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326), (0,
5326), (0, 5326), (0, 5326), (0, 5326)]
3382 6857176.8180432785
3383 End node is [24]
3384 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
15, 16, 17, 18, 19, 20, 21, 22, 23]
3385 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37,
38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
50, 51, 52, 53, 54]
3386 Objective: 2445
3387 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
17 18 19 20 21 22
3388 54
```

```
3389 54
3390 54
3391 54
3392 54
3393 54
3394 54
3395 54
3396 54
3397 54
3398 54
3399 54
3400 54
3401 54
3402 54
3403 54
3404 54
3405 54
3406 54
3407 54
3408 54
3409 54
3410 54
3411 54
3412 54
3413 54
3414 54
3415 54
3416 54
3417 54
3418 54
3419 54
3420 Route for vehicle 0:
3421 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
```

3421 Time(897,1557) Slack(0) FuelSlack(0,0) Distance(29715) -> 31 Fuel(104340) Time(922,1702) Slack(0) FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270) Time(966,1806) Slack(0) FuelSlack(0,0) Distance(31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0) FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124) Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0) FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296) Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0) FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156) Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel(277878) Time(2748,2748) Slack(0) FuelSlack(0,0) Distance(38907) -> 52 Fuel(261042) Time(2833,2833) Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(243996) Time(2919,2919) Slack(0) FuelSlack(0,0) Distance(44554) -> 50 Fuel(227184) Time(3003,3003) Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(210348) Time(3088,3088) Slack(0) FuelSlack(0,0) Distance(50162) -> 48 Fuel(193302) Time(3174,3174) Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(176490) Time(3258,3258) Slack(0) FuelSlack(0,0) Distance(55805) -> 46 Fuel(159654) Time(3343,3343) Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(142608) Time(3429,3429) Slack(0) FuelSlack(0,0) Distance(61452) -> 44 Fuel(125796) Time(3513,3513) Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(108750) Time(3599,3599) Slack(0) FuelSlack(0,0) Distance(67095) -> 42 Fuel(92148) Time(3682,3682) Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(75102) Time(3768,3768) Slack(0) FuelSlack(0,0) Distance(72703) -> 40 Fuel(58056) Time(3854,3854) Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(41454) Time(3937,3937) Slack(0) FuelSlack(0,0) Distance(78311) -> 23 Fuel(24408) Time(4023,4023) Slack(846) FuelSlack(24408,287700) Distance(81152) -> 24 Fuel(287700) Time(4869,4869) Distance(81152)


```
3443 6977176.8180432785
3444 End node is [24]
3445 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
3446 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
3447 Objective: 8002624
3448 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
3449 55
3450 55
3451 55
3452 55
3453 55
3454 55
3455 55
3456 55
3457 55
3458 55
3459 55
3460 55
3461 55
3462 55
3463 55
3464 55
3465 55
3466 55
3467 55
3468 55
3469 55
3470 55
3471 55
3472 55
3473 Route for vehicle 0:
3474 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
      72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
      129384) Time(930,978) Slack(72) FuelSlack(0,0)
      Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
      Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
```

```

3474 (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3475 Distance of the route: 86983 ft
3476 Remaining Fuel of the route: 3996
3477 Total Time of the route: 5321 seconds
3478
3479 Total Distance of all routes: 86983 ft
3480 Total Fuel remaining of all routes: 3996
3481 Total Time of all routes: 5321 seconds
3482 Objective value is: 8002624
3483 -----

```

```
3484 UAV optimization via conventional feedforward
      solution
3485 -----
3486 Start point is: 5
3487 Parameters are: 7, 5, 5
3488 16
3489 31
3490 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
      5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
      : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
      5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
      .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
      , 6.26)]}
3491 (5.77, 5.83) (5.35, 6.1)
3492 10 10
3493 The travel time for UGV from depot B to NW UGV stop
      is: 1589
3494 The UGV travel time between two UGV stops is: 1237
3495 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326
      ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889
      ), (1589, 1889), (1589, 1889), (1589, 1889), (1589
      , 1889), (3126, 3426), (3126, 3426), (3126, 3426
      ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
      5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
      ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
      5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
      ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
      5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
      ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
      5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
      ), (0, 5326), (0, 5326), (0, 5326), (0, 5326)]
3496 6857176.8180432785
3497 End node is [24]
3498 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
      15, 16, 17, 18, 19, 20, 21, 22, 23]
3499 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
3500 Objective: 8002624
3501 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
      16 17 19 20 21 22 23 40 41 42 43 44 45 46 47
```

```
3502 55
3503 55
3504 55
3505 55
3506 55
3507 55
3508 55
3509 55
3510 55
3511 55
3512 55
3513 55
3514 55
3515 55
3516 55
3517 55
3518 55
3519 55
3520 55
3521 55
3522 55
3523 55
3524 55
3525 55
3526 Route for vehicle 0:
3527 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
```

```

3527 Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3528 Distance of the route: 86983 ft
3529 Remaining Fuel of the route: 3996
3530 Total Time of the route: 5321 seconds
3531
3532 Total Distance of all routes: 86983 ft
3533 Total Fuel remaining of all routes: 3996
3534 Total Time of all routes: 5321 seconds
3535 -----
3536 UAV optimization via conventional feedforward
    solution
3537 -----
3538 Start point is: 5
3539 Parameters are: 5, 15, 40
3540 16
3541 31
3542 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .35, 6.1)]}

```

```
3542 .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35  
, 6.26)]}  
3543 (5.35, 6.26) (5.77, 5.83)  
3544 10 10  
3545 The travel time for UGV from depot B to NW UGV stop  
is: 1980  
3546 The UGV travel time between two UGV stops is: 1322  
3547 [(0, 60), (0, 8191), (0, 8191), (0, 8191), (0, 8191  
, (0, 8191), (0, 8191), (1980, 2880), (1980, 2880  
, (1980, 2880), (1980, 2880), (1980, 2880), (1980  
, 2880), (4202, 6602), (4202, 6602), (4202, 6602  
, (4202, 6602), (4202, 6602), (4202, 6602), (0,  
8191), (0, 8191), (0, 8191), (0, 8191), (0, 8191  
, (0, 8191), (0, 8191), (0, 8191), (0, 8191), (0,  
8191), (0, 8191), (0, 8191), (0, 8191), (0, 8191  
, (0, 8191), (0, 8191), (0, 8191), (0, 8191), (0,  
8191), (0, 8191), (0, 8191), (0, 8191), (0, 8191  
, (0, 8191), (0, 8191), (0, 8191), (0, 8191), (0,  
8191), (0, 8191), (0, 8191), (0, 8191), (0, 8191  
, (0, 8191), (0, 8191), (0, 8191), (0, 8191), (0,  
8191), (0, 8191), (0, 8191), (0, 8191)]  
3548 7689712.12724779  
3549 End node is [24]  
3550 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17, 18, 19, 20, 21, 22, 23]  
3551 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37  
, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,  
50, 51, 52, 53]  
3552 Objective: 8002624  
3553 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15  
16 17 19 20 21 22 23 40 41 42 43 44 45 46 47  
3554 55  
3555 55  
3556 55  
3557 55  
3558 55  
3559 55  
3560 55  
3561 55  
3562 55  
3563 55  
3564 55
```

```
3565 55
3566 55
3567 55
3568 55
3569 55
3570 55
3571 55
3572 55
3573 55
3574 55
3575 55
3576 55
3577 55
3578 Route for vehicle 0:
3579 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
    Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
```

```

3579 ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 24 Fuel(3996) Time(5321,5321) Distance(
    86983)

3580 Distance of the route: 86983 ft
3581 Remaining Fuel of the route: 3996
3582 Total Time of the route: 5321 seconds
3583
3584 Total Distance of all routes: 86983 ft
3585 Total Fuel remaining of all routes: 3996
3586 Total Time of all routes: 5321 seconds
3587 ***** Execute updated local
    optimization*****
3588 -----
    -----
3589 ***** UAV optimization via feedback
    solution*****
3590 -----
    -----
3591 Start point is: 5
3592 Parameters are: 7, 5, 5
3593 16
3594 31
3595 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
3596 (5.77, 5.83) (5.35, 6.1)
3597 10 10
3598 The travel time for UGV from depot B to NW UGV stop
    is: 1589
3599 The UGV travel time between two UGV stops is: 1237

```

```
3600 [(0, 60), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326),
       ), (0, 5326), (0, 5326), (1589, 1889), (1589, 1889),
       ), (1589, 1889), (1589, 1889), (1589, 1889), (1589,
       , 1889), (3126, 3426), (3126, 3426), (3126, 3426
       ), (3126, 3426), (3126, 3426), (3126, 3426), (0,
       5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
       ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
       5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
       ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
       5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
       ), (0, 5326), (0, 5326), (0, 5326), (0, 5326), (0,
       5326), (0, 5326), (0, 5326), (0, 5326), (0, 5326
       ), (0, 5326), (0, 5326), (0, 5326)]  
3601 6857176.8180432785  
3602 End node is [24]  
3603 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,
       15, 16, 17, 18, 19, 20, 21, 22, 23]  
3604 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
       , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
       50, 51, 52, 53, 54]  
3605 Objective: 4044  
3606 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
       17 18 19 20 21 22  
3607 54  
3608 54  
3609 54  
3610 54  
3611 54  
3612 54  
3613 54  
3614 54  
3615 54  
3616 54  
3617 54  
3618 54  
3619 54  
3620 54  
3621 54  
3622 54  
3623 54  
3624 54
```

```
3625 54
3626 54
3627 54
3628 54
3629 54
3630 54
3631 54
3632 54
3633 54
3634 54
3635 54
3636 54
3637 54
3638 54
3639 Route for vehicle 0:
3640 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
    0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384
    ) Time(798,978) Slack(0) FuelSlack(0,0) Distance(
    26386) -> 27 Fuel(124308) Time(823,1123) Slack(0)
    FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556)
    Time(847,1267) Slack(0) FuelSlack(0,0) Distance(
    28024) -> 29 Fuel(114486) Time(872,1412) Slack(0)
    FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410)
    Time(897,1557) Slack(0) FuelSlack(0,0) Distance(
    29715) -> 31 Fuel(104340) Time(922,1702) Slack(0)
    FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270)
    Time(966,1806) Slack(0) FuelSlack(0,0) Distance(
    31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0)
    FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124)
    Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(
    33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0)
    FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296)
    Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(
    34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0)
    FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156)
    Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(
    36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719
    ) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel
    (277878) Time(2748,2748) Slack(0) FuelSlack(0,0)
    Distance(38907) -> 52 Fuel(261042) Time(2833,2833)
```

```

3640 Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(243996) Time(2919,2919) Slack(0) FuelSlack(0,0) Distance(44554) -> 50 Fuel(227184) Time(3003,3003) Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(210348) Time(3088,3088) Slack(0) FuelSlack(0,0) Distance(50162) -> 48 Fuel(193302) Time(3174,3174) Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(176490) Time(3258,3258) Slack(0) FuelSlack(0,0) Distance(55805) -> 46 Fuel(159654) Time(3343,3343) Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(142608) Time(3429,3429) Slack(0) FuelSlack(0,0) Distance(61452) -> 44 Fuel(125796) Time(3513,3513) Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(108750) Time(3599,3599) Slack(0) FuelSlack(0,0) Distance(67095) -> 42 Fuel(92148) Time(3682,3682) Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(75102) Time(3768,3768) Slack(0) FuelSlack(0,0) Distance(72703) -> 40 Fuel(58056) Time(3854,3854) Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(41454) Time(3937,3937) Slack(0) FuelSlack(0,0) Distance(78311) -> 23 Fuel(24408) Time(4023,4023) Slack(846) FuelSlack(24408,287700) Distance(81152) -> 24 Fuel(287700) Time(6468,6468) Distance(133951)

3641 Distance of the route: 133951 ft
3642 Remaining Fuel of the route: 287700
3643 Total Time of the route: 6468 seconds
3644
3645 Total Distance of all routes: 133951 ft
3646 Total Fuel remaining of all routes: 287700
3647 Total Time of all routes: 6468 seconds
3648 ***** Execute updated global optimization*****
3649 -----
-----  

3650 ***** UAV optimization via feedback solution*****
3651 -----
-----  

3652 Start point is: 5
3653 Parameters are: 5, 15, 40

```



```
3673 55
3674 55
3675 55
3676 55
3677 55
3678 55
3679 55
3680 55
3681 55
3682 55
3683 55
3684 55
3685 55
3686 55
3687 55
3688 55
3689 55
3690 55
3691 55
3692 55
3693 55
3694 55
3695 55
3696 55
3697 55
3698 55
3699 55
3700 Route for vehicle 0:
3701 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
```

3701 Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
 Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
 (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
 Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
 Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
 (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
 Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
 Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
 (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
 Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
 Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
 (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
 Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
 Slack(765) FuelSlack(70127,70158) Distance(39699
) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
 FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
 Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
 45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
 FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
 Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
 51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
 FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
 Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
 57233) -> 47 Fuel(165660) Time(4505,4505) Slack(0)
 FuelSlack(0,0) Distance(60039) -> 46 Fuel(148614)
 Time(4591,4591) Slack(0) FuelSlack(0,0) Distance(
 62880) -> 45 Fuel(131802) Time(4675,4675) Slack(0)
 FuelSlack(0,0) Distance(65682) -> 44 Fuel(114756)
 Time(4761,4761) Slack(0) FuelSlack(0,0) Distance(
 68523) -> 43 Fuel(98154) Time(4844,4844) Slack(0)
 FuelSlack(0,0) Distance(71290) -> 42 Fuel(81108)
 Time(4930,4930) Slack(0) FuelSlack(0,0) Distance(
 74131) -> 41 Fuel(64062) Time(5016,5016) Slack(0)
 FuelSlack(0,0) Distance(76972) -> 40 Fuel(47460)
 Time(5099,5099) Slack(0) FuelSlack(0,0) Distance(
 79739) -> 24 Fuel(30414) Time(5185,5185) Distance(
 82580)
 3702 Distance of the route: 82580 ft
 3703 Remaining Fuel of the route: 30414
 3704 Total Time of the route: 5185 seconds
 3705


```
3725 [25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37
      , 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49,
      50, 51, 52, 53, 54]
3726 Objective: 2445
3727 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 13 14 15 16
                  17 18 19 20 21 22
3728 54
3729 54
3730 54
3731 54
3732 54
3733 54
3734 54
3735 54
3736 54
3737 54
3738 54
3739 54
3740 54
3741 54
3742 54
3743 54
3744 54
3745 54
3746 54
3747 54
3748 54
3749 54
3750 54
3751 54
3752 54
3753 54
3754 54
3755 54
3756 54
3757 54
3758 54
3759 54
3760 Route for vehicle 0:
3761 0 Fuel(287700) Time(0,0) Slack(0) FuelSlack(0,0)
      Distance(0) -> 25 Fuel(134454) Time(773,833) Slack(
```

3761	0) FuelSlack(0,0) Distance(25541) -> 26 Fuel(129384)) Time(798,978) Slack(0) FuelSlack(0,0) Distance(26386) -> 27 Fuel(124308) Time(823,1123) Slack(0) FuelSlack(0,0) Distance(27232) -> 28 Fuel(119556) Time(847,1267) Slack(0) FuelSlack(0,0) Distance(28024) -> 29 Fuel(114486) Time(872,1412) Slack(0) FuelSlack(0,0) Distance(28869) -> 30 Fuel(109410) Time(897,1557) Slack(0) FuelSlack(0,0) Distance(29715) -> 31 Fuel(104340) Time(922,1702) Slack(0) FuelSlack(0,0) Distance(30560) -> 32 Fuel(99270) Time(966,1806) Slack(0) FuelSlack(0,0) Distance(31405) -> 33 Fuel(94194) Time(1111,1831) Slack(0) FuelSlack(0,0) Distance(32251) -> 34 Fuel(89124) Time(1256,1856) Slack(0) FuelSlack(0,0) Distance(33096) -> 35 Fuel(84372) Time(1400,1880) Slack(0) FuelSlack(0,0) Distance(33888) -> 36 Fuel(79296) Time(1545,1905) Slack(0) FuelSlack(0,0) Distance(34734) -> 37 Fuel(74226) Time(1690,1930) Slack(0) FuelSlack(0,0) Distance(35579) -> 38 Fuel(69156) Time(1835,1955) Slack(0) FuelSlack(0,0) Distance(36424) -> 12 Fuel(64080) Time(1980,1980) Slack(719)) FuelSlack(73603,73902) Distance(37270) -> 53 Fuel (277878) Time(2748,2748) Slack(0) FuelSlack(0,0) Distance(38907) -> 52 Fuel(261042) Time(2833,2833) Slack(0) FuelSlack(0,0) Distance(41713) -> 51 Fuel(243996) Time(2919,2919) Slack(0) FuelSlack(0,0) Distance(44554) -> 50 Fuel(227184) Time(3003,3003) Slack(0) FuelSlack(0,0) Distance(47356) -> 49 Fuel(210348) Time(3088,3088) Slack(0) FuelSlack(0,0) Distance(50162) -> 48 Fuel(193302) Time(3174,3174) Slack(0) FuelSlack(0,0) Distance(53003) -> 47 Fuel(176490) Time(3258,3258) Slack(0) FuelSlack(0,0) Distance(55805) -> 46 Fuel(159654) Time(3343,3343) Slack(0) FuelSlack(0,0) Distance(58611) -> 45 Fuel(142608) Time(3429,3429) Slack(0) FuelSlack(0,0) Distance(61452) -> 44 Fuel(125796) Time(3513,3513) Slack(0) FuelSlack(0,0) Distance(64254) -> 43 Fuel(108750) Time(3599,3599) Slack(0) FuelSlack(0,0) Distance(67095) -> 42 Fuel(92148) Time(3682,3682) Slack(0) FuelSlack(0,0) Distance(69862) -> 41 Fuel(75102) Time(3768,3768) Slack(0) FuelSlack(0,0)
------	--

```
3761 Distance(72703) -> 40 Fuel(58056) Time(3854,3854)
    Slack(0) FuelSlack(0,0) Distance(75544) -> 39 Fuel(
    41454) Time(3937,3937) Slack(0) FuelSlack(0,0)
    Distance(78311) -> 23 Fuel(24408) Time(4023,4023)
    Slack(846) FuelSlack(24408,287700) Distance(81152
    ) -> 24 Fuel(287700) Time(4869,4869) Distance(81152
    )
3762 Distance of the route: 81152 ft
3763 Remaining Fuel of the route: 287700
3764 Total Time of the route: 4869 seconds
3765
3766 Total Distance of all routes: 81152 ft
3767 Total Fuel remaining of all routes: 287700
3768 Total Time of all routes: 4869 seconds
3769 Global population dict is: {(6, 16, 16, 5): 2048, (
    5, 15, 31, 5): 2782, (5, 15, 21, 5): 2182, (5, 15,
    40, 5): 3322}
3770 -----
3771 UAV optimization via conventional feedforward
    solution
3772 -----
3773 Start point is: 3
3774 Parameters are: 2, 13, 31
3775 16
3776 16
3777 {2: [(5.35, 6.1), (5.56, 5.89)], 3: [(5.35, 6.1), (
    5.77, 5.83)], 4: [(5.35, 6.26), (5.56, 5.89)], 5
    : [(5.35, 6.26), (5.77, 5.83)], 6: [(5.56, 5.89), (
    5.35, 6.1)], 7: [(5.77, 5.83), (5.35, 6.1)], 8: [(5
    .56, 5.89), (5.35, 6.26)], 9: [(5.77, 5.83), (5.35
    , 6.26)]}
3778 (5.35, 6.1) (5.56, 5.89)
3779 10 10
3780 The travel time for UGV from depot B to NW UGV stop
    is: 3328
3781 The UGV travel time between two UGV stops is: 1121
3782 [(3249, 3309), (3328, 4108), (3328, 4108), (3328,
    4108), (3328, 4108), (3328, 4108), (3328, 4108), (
    5229, 7089), (5229, 7089), (5229, 7089), (5229,
    7089), (5229, 7089), (5229, 7089), (0, 14678), (0,
    14678), (0, 14678), (0, 14678), (0, 14678), (7205,
```

```
3782 14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678), (0, 14678), (0,
14678), (0, 14678), (0, 14678)]  
3783 ****  
***  
3784 UGV route goes infeasible although UAV has a  
solution  
3785 ****  
***  
3786 27037017.837732397  
3787 End node is [18]  
3788 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14,  
15, 16, 17]  
3789 [19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31  
, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43,  
44, 45, 46, 47, 48]  
3790 Objective: 2488  
3791 Dropped nodes: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15  
16 17 19 20 21 22 23  
3792 55  
3793 55  
3794 55  
3795 55  
3796 55  
3797 55  
3798 55  
3799 55  
3800 55  
3801 55  
3802 55  
3803 55  
3804 55  
3805 55  
3806 55  
3807 55  
3808 55
```

```
3809 55
3810 55
3811 55
3812 55
3813 55
3814 55
3815 55
3816 55
3817 55
3818 55
3819 55
3820 55
3821 55
3822 55
3823 55
3824 Route for vehicle 0:
3825 0 Fuel(287700) Time(0,0) Slack(12) FuelSlack(0,0)
    Distance(0) -> 25 Fuel(134454) Time(785,833) Slack(
    72) FuelSlack(0,0) Distance(25541) -> 26 Fuel(
    129384) Time(930,978) Slack(72) FuelSlack(0,0)
    Distance(26386) -> 27 Fuel(124308) Time(1075,1123)
    Slack(72) FuelSlack(0,0) Distance(27232) -> 28 Fuel
    (119556) Time(1219,1267) Slack(72) FuelSlack(0,0)
    Distance(28024) -> 29 Fuel(114486) Time(1364,1412)
    Slack(72) FuelSlack(0,0) Distance(28869) -> 30 Fuel
    (109410) Time(1509,1557) Slack(72) FuelSlack(0,0)
    Distance(29715) -> 31 Fuel(104340) Time(1654,1702)
    Slack(72) FuelSlack(0,0) Distance(30560) -> 32 Fuel
    (99270) Time(1799,1847) Slack(72) FuelSlack(0,0)
    Distance(31405) -> 33 Fuel(94194) Time(1944,1992)
    Slack(72) FuelSlack(0,0) Distance(32251) -> 34 Fuel
    (89124) Time(2089,2137) Slack(72) FuelSlack(0,0)
    Distance(33096) -> 35 Fuel(84372) Time(2233,2281)
    Slack(72) FuelSlack(0,0) Distance(33888) -> 36 Fuel
    (79296) Time(2378,2426) Slack(72) FuelSlack(0,0)
    Distance(34734) -> 37 Fuel(74226) Time(2523,2571)
    Slack(72) FuelSlack(0,0) Distance(35579) -> 38 Fuel
    (69156) Time(2668,2716) Slack(72) FuelSlack(0,0)
    Distance(36424) -> 39 Fuel(64080) Time(2813,2861)
    Slack(72) FuelSlack(0,0) Distance(37270) -> 54 Fuel
    (54258) Time(2982,3030) Slack(72) FuelSlack(0,0)
```

```

3825 Distance(38907) -> 18 Fuel(49506) Time(3126,3126)
    Slack(765) FuelSlack(70127,70158) Distance(39699
    ) -> 53 Fuel(267048) Time(3995,3995) Slack(0)
    FuelSlack(0,0) Distance(43141) -> 52 Fuel(250002)
    Time(4081,4081) Slack(0) FuelSlack(0,0) Distance(
    45982) -> 51 Fuel(233190) Time(4165,4165) Slack(0)
    FuelSlack(0,0) Distance(48784) -> 50 Fuel(216354)
    Time(4250,4250) Slack(0) FuelSlack(0,0) Distance(
    51590) -> 49 Fuel(199308) Time(4336,4336) Slack(0)
    FuelSlack(0,0) Distance(54431) -> 48 Fuel(182496)
    Time(4420,4420) Slack(0) FuelSlack(0,0) Distance(
    57233) -> 47 Fuel(165660) Time(4505,4505) Slack(0)
    FuelSlack(0,0) Distance(60039) -> 46 Fuel(148614)
    Time(4591,4591) Slack(0) FuelSlack(0,0) Distance(
    62880) -> 45 Fuel(131802) Time(4675,4675) Slack(0)
    FuelSlack(0,0) Distance(65682) -> 44 Fuel(114756)
    Time(4761,4761) Slack(0) FuelSlack(0,0) Distance(
    68523) -> 43 Fuel(98154) Time(4844,4844) Slack(0)
    FuelSlack(0,0) Distance(71290) -> 42 Fuel(81108)
    Time(4930,4930) Slack(0) FuelSlack(0,0) Distance(
    74131) -> 41 Fuel(64062) Time(5016,5016) Slack(0)
    FuelSlack(0,0) Distance(76972) -> 40 Fuel(47460)
    Time(5099,5099) Slack(0) FuelSlack(0,0) Distance(
    79739) -> 24 Fuel(30414) Time(5185,5185) Distance(
    82580)

3826 Distance of the route: 82580 ft
3827 Remaining Fuel of the route: 30414
3828 Total Time of the route: 5185 seconds
3829
3830 Total Distance of all routes: 82580 ft
3831 Total Fuel remaining of all routes: 30414
3832 Total Time of all routes: 5185 seconds
3833 Local population: {(5, 15, 31, 5): 2782, (6, 16,
    16, 5): 2048, (7, 20, 0, 5): 1377, (7, 5, 5, 5):
    141}
3834 Objective: 1867
3835 Dropped nodes: 1 2 3 4 5 6 8 9 10 11 13 14 15 16 17
3836 49
3837 49
3838 49
3839 49

```

```
3840 49
3841 49
3842 49
3843 49
3844 49
3845 49
3846 49
3847 49
3848 49
3849 49
3850 49
3851 49
3852 49
3853 49
3854 49
3855 49
3856 49
3857 49
3858 49
3859 49
3860 49
3861 49
3862 49
3863 49
3864 49
3865 49
3866 49
3867 49
3868 49
3869 Route for vehicle 0:
3870 0 Fuel(287700) Time(3249,3249) Slack(0) FuelSlack(0
,0) Distance(0) -> 33 Fuel(277878) Time(3298,3358)
Slack(0) FuelSlack(0,0) Distance(1637) -> 32 Fuel(
272802) Time(3323,3503) Slack(0) FuelSlack(0,0)
Distance(2483) -> 31 Fuel(267732) Time(3348,3648)
Slack(0) FuelSlack(0,0) Distance(3328) -> 30 Fuel(
262662) Time(3373,3793) Slack(0) FuelSlack(0,0)
Distance(4173) -> 29 Fuel(257586) Time(3398,3938)
Slack(0) FuelSlack(0,0) Distance(5019) -> 28 Fuel(
252834) Time(3422,4082) Slack(0) FuelSlack(0,0)
Distance(5811) -> 27 Fuel(247764) Time(3534,4227)
```

3870 Slack(0) FuelSlack(0,0) Distance(6656) -> 26 Fuel(242688) Time(3679,4372) Slack(0) FuelSlack(0,0) Distance(7502) -> 25 Fuel(237618) Time(3824,4517) Slack(0) FuelSlack(0,0) Distance(8347) -> 24 Fuel(232548) Time(3969,4662) Slack(0) FuelSlack(0,0) Distance(9192) -> 23 Fuel(227472) Time(4114,4714) Slack(0) FuelSlack(0,0) Distance(10038) -> 22 Fuel(222402) Time(4259,4739) Slack(0) FuelSlack(0,0) Distance(10883) -> 21 Fuel(217650) Time(4403,4763) Slack(0) FuelSlack(0,0) Distance(11675) -> 20 Fuel(212574) Time(4548,4788) Slack(0) FuelSlack(0,0) Distance(12521) -> 19 Fuel(207504) Time(4693,4813) Slack(0) FuelSlack(0,0) Distance(13366) -> 7 Fuel(125040) Time(5229,5229) Slack(523) FuelSlack(199539,199842) Distance(27110) -> 44 Fuel(212898) Time(6129,6129) Slack(0) FuelSlack(0,0) Distance(39577) -> 45 Fuel(205980) Time(6163,6163) Slack(0) FuelSlack(0,0) Distance(40730) -> 46 Fuel(199062) Time(6197,6197) Slack(0) FuelSlack(0,0) Distance(41883) -> 47 Fuel(192451) Time(6230,6230) Slack(0) FuelSlack(0,0) Distance(42985) -> 48 Fuel(185533) Time(6264,6264) Slack(0) FuelSlack(0,0) Distance(44138) -> 43 Fuel(151549) Time(6435,6435) Slack(0) FuelSlack(0,0) Distance(49802) -> 42 Fuel(144709) Time(6469,6469) Slack(0) FuelSlack(0,0) Distance(50942) -> 41 Fuel(137791) Time(6503,6503) Slack(0) FuelSlack(0,0) Distance(52095) -> 40 Fuel(131180) Time(6536,6536) Slack(0) FuelSlack(0,0) Distance(53197) -> 39 Fuel(124262) Time(6570,6570) Slack(0) FuelSlack(0,0) Distance(54350) -> 38 Fuel(117344) Time(6604,6604) Slack(0) FuelSlack(0,0) Distance(55503) -> 37 Fuel(110733) Time(6637,6637) Slack(0) FuelSlack(0,0) Distance(56605) -> 36 Fuel(103815) Time(6671,6671) Slack(0) FuelSlack(0,0) Distance(57758) -> 35 Fuel(96897) Time(6705,6705) Slack(0) FuelSlack(0,0) Distance(58911) -> 34 Fuel(90286) Time(6738,6738) Slack(0) FuelSlack(0,0) Distance(60013) -> 12 Fuel(83368) Time(6772,6772) Slack(657) FuelSlack(83368,287700) Distance(61166) -> 18 Fuel(287700) Time(7463,7463) Distance(62319)

3871 Distance of the route: 62319 ft

```
3872 Remaining Fuel of the route: 287700
3873 Total Time of the route: 7463 seconds
3874
3875 Total Distance of all routes: 62319 ft
3876 Total Fuel remaining of all routes: 287700
3877 Total Time of all routes: 7463 seconds
3878 Global population dict is: {(6, 16, 16, 5): 2048, (
    5, 15, 31, 5): 2782, (5, 15, 21, 5): 2182, (5, 15,
    40, 5): 3322, (2, 13, 31, 3): 7215}
3879 Global population dict is: {(6, 16, 16, 5): 2048, (
    5, 15, 31, 5): 2782, (5, 15, 21, 5): 2182, (5, 15,
    40, 5): 3322, (2, 13, 31, 3): 7215}
3880 [1, 1, 1, 1, 0]
3881 Sorted idcs length is 5
3882 code switch length is 5
3883 Code switch addition: 1
3884 Sorted list is : [1]
3885 Code switch addition: 1
3886 Sorted list is : [1, 1]
3887 Code switch addition: 1
3888 Sorted list is : [1, 1, 1]
3889 Code switch addition: 1
3890 Sorted list is : [1, 1, 1, 1]
3891 Code switch addition: 0
3892 Sorted list is : [1, 1, 1, 1, 0]
3893 {(7, 5, 5, 5): 141, (7, 20, 0, 5): 1377, (6, 16, 16,
    , 5): 2048, (5, 15, 21, 5): 2182, (5, 15, 31, 5):
    2782, (5, 15, 40, 5): 3322, (2, 13, 31, 3): 7215, (
    6, 50, 24, 3): 7473, (2, 13, 40, 3): 7473, (7, 30,
    31, 4): 6003045, (6, 20, 36, 4): 50000000, (4, 12,
    21, 2): 50000000, (4, 6, 50, 2): 50000000}
3894 Elapsed time = 696.8726007938385
3895
3896 Process finished with exit code 0
3897
```