In [1]:
```
from Point import Point
from Trips import Trips
from Trip import Trip
from Simulation import Simulation
from Solver import Solver
import time
import pickle
import numpy as np
import matplotlib.pyplot as plt
```

In [22]:
```
for n_simulation in range(2,3):
    result_simulation=[]
    for i in range(10):
        print(f'n_simulation={n_simulation} i={i}')
        n,m,ks,kr,kn,T_start,c=Simulation.get_simulation_number(n_simulat
        J,D=Simulation.initialize_map(n)

        start_time = time.time()
        # trips_problem=Solver.trptr_problem(n,m,J,D,Point(0,0),Point(0,0
        trips_problem=[]
        execution_time_problem=time.time()-start_time

        start_time = time.time()
        trips=Solver.sa_approach(n, m, ks, kr, kn, T_start, c, J, D, Poin
        execution_sa=time.time()-start_time

        start_time = time.time()
        trips_sam=Solver.sam_matheuristic(n, m, J, D, trips,time_limit=60
        execution_sam=time.time()-start_time

        start_time = time.time()
        trips_sam_ls=Solver.local_search(n,m,J, D, 100000,trips_sam)
        execution_sam_ls=time.time()-start_time

        start_time = time.time()
        trips_sm=Solver.sm_matheuristic(J,D,trips)
        execution_sm=time.time()-start_time

        start_time = time.time()
        trips_sm_ls=Solver.local_search(n,m,J, D, 100000,trips_sm)
        execution_sm_ls=time.time()-start_time


        travel_time_problem=Trips.get_total_duration(trips_problem)
        travel_time_sam=Trips.get_total_duration(trips_sam_ls)
        travel_time_sm=Trips.get_total_duration(trips_sm_ls)

        total_time_sma=execution_sa+execution_sam+execution_sam_ls
        total_time_sm=execution_sa+execution_sm+execution_sm_ls

        result_simulation.append( (J,D,
                                   trips_problem,execution_time_problem,
                                   trips,execution_sa,
                                   trips_sam,execution_sam,
                                   trips_sam_ls,execution_sam_ls,
                                   trips_sm,execution_sm,
                                   trips_sm_ls,execution_sm_ls
                                   ))
    with open(f'result_simulation_{n_simulation}.pkl', 'wb') as f:  # Pyt
        pickle.dump(result_simulation, f)
```

```
n_simulation=2 i=0
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
```

```
Optimize a model with 609 rows, 558 columns and 2072 nonzeros
Model fingerprint: 0x96ea9215
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [8e-01, 1e+02]
  Objective range  [1e+00, 8e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 918.8463658
Presolve removed 97 rows and 0 columns
Presolve time: 0.00s
Presolved: 512 rows, 558 columns, 1975 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.778412e+02, 657 iterations, 0.01 seconds (0.
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  377.84122    0  358  918.84637  377.84122  58.9%     -    0
s
H    0     0                       665.6246527  377.84122  43.2%     -    0
s
H    0     0                       608.2945791  377.84122  37.9%     -    0
s
H    0     0                       604.9046981  377.84122  37.5%     -    0
s
H    0     0                       601.2441461  422.13637  29.8%     -    0
s
     0     0  422.13637    0  352  601.24415  422.13637  29.8%     -    0
s
     0     0  422.40611    0  345  601.24415  422.40611  29.7%     -    0
s
     0     0  422.40639    0  346  601.24415  422.40639  29.7%     -    0
s
     0     0  428.00767    0  340  601.24415  428.00767  28.8%     -    0
s
     0     0  428.00767    0  340  601.24415  428.00767  28.8%     -    0
s
H    0     0                       520.9537760  428.00767  17.8%     -    0
s
     0     2  428.00767    0  340  520.95378  428.00767  17.8%     -    0
s
H   71    88                       520.7321382  428.00767  17.8%  64.3    0
s
H  109   132                       519.1746477  428.00767  17.6%  44.5    0
s
H  267   277                       518.8405307  428.00767  17.5%  25.2    0
s
H  347   358                       518.8405300  428.00767  17.5%  21.6    0
s
H 1039   826                       518.0581819  435.38617  16.0%  22.2    1
s
H 1043   786                       517.9215812  435.38617  15.9%  22.1    2
s
```

```
H 1043   747                    517.4647986  435.38617  15.9%  22.1    2
s
H 1058   718                    516.7435044  437.11597  15.4%  21.8    2
s
H 1066   687                    514.4359189  438.79976  14.7%  21.6    3
s
H 1080   661                    514.4359181  440.92411  14.3%  21.3    4
s
  1104   686  458.41429   17  324  514.43592  443.45058  13.8%  38.7    5
s
  1957  1078  495.62308   46  230  514.43592  450.08230  12.5%  90.0   10
s
  3295  1581  456.63007   23  331  514.43592  452.80932  12.0%  92.7   15
s
  4514  2464  512.00903   38  199  514.43592  454.74733  11.6%   102   20
s
  5754  3313  492.41817   81  188  514.43592  455.60646  11.4%   100   25
s
  7165  4307  468.97949   26  307  514.43592  457.42524  11.1%   102   30
s
  8754  5543  507.92549   73  161  514.43592  458.59595  10.9%   103   35
s
H 9357  5775                    514.1949358  458.63273  10.8%   102   36
s
 10515  6790  493.83171   34  225  514.19494  459.87137  10.6%   102   40
s
 12009  7696  488.10180   50  246  514.19494  460.13614  10.5%   103   45
s
 12975  8122  484.61834   38  206  514.19494  460.55490  10.4%   105   52
s
 13720  8899  472.34388   32  278  514.19494  460.74337  10.4%   104   55
s
 14807  9273     cutoff   60       514.19494  461.21854  10.3%   104   60
s

Cutting planes:
  Gomory: 52
  Cover: 3
  MIR: 147
  Flow cover: 803
  RLT: 42
  Relax-and-lift: 767

Explored 14819 nodes (1543533 simplex iterations) in 60.02 seconds (70.86
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 514.195 514.436 514.436 ... 519.175

Time limit reached
Best objective 5.141949358048e+02, best bound 4.612185429408e+02, gap 10.
3028%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 5 is executed on taxi trip 0
```

```
realocation move 14 is executed on taxi trip 0
realocation move 23 is executed on taxi trip 0
realocation move 26 is executed on taxi trip 0
realocation move 27 is executed on taxi trip 0
realocation move 29 is executed on taxi trip 0
realocation move 30 is executed on taxi trip 0
realocation move 56 is executed on taxi trip 0
realocation move 4 is executed on taxi trip 1
realocation move 11 is executed on taxi trip 1
realocation move 19 is executed on taxi trip 1
realocation move 33 is executed on taxi trip 1
realocation move 39 is executed on taxi trip 1
realocation move 49 is executed on taxi trip 1
realocation move 52 is executed on taxi trip 1
realocation move 53 is executed on taxi trip 1
realocation move 10 is executed on taxi trip 3
realocation move 16 is executed on taxi trip 3
realocation move 20 is executed on taxi trip 3
realocation move 43 is executed on taxi trip 3
realocation move 44 is executed on taxi trip 3
realocation move 50 is executed on taxi trip 3
realocation move 51 is executed on taxi trip 3
realocation move 58 is executed on taxi trip 3
realocation move 0 is executed on taxi trip 4
realocation move 17 is executed on taxi trip 4
realocation move 45 is executed on taxi trip 4
realocation move 46 is executed on taxi trip 4
realocation move 7 is executed on taxi trip 5
realocation move 9 is executed on taxi trip 5
realocation move 18 is executed on taxi trip 5
realocation move 21 is executed on taxi trip 5
realocation move 25 is executed on taxi trip 5
realocation move 32 is executed on taxi trip 5
realocation move 34 is executed on taxi trip 5
realocation move 38 is executed on taxi trip 5
realocation move 3 is executed on taxi trip 6
realocation move 12 is executed on taxi trip 6
realocation move 15 is executed on taxi trip 6
realocation move 22 is executed on taxi trip 6
realocation move 36 is executed on taxi trip 6
realocation move 37 is executed on taxi trip 6
realocation move 48 is executed on taxi trip 6
realocation move 59 is executed on taxi trip 6
realocation move 1 is executed on taxi trip 7
realocation move 6 is executed on taxi trip 7
realocation move 13 is executed on taxi trip 7
realocation move 24 is executed on taxi trip 7
realocation move 40 is executed on taxi trip 7
realocation move 41 is executed on taxi trip 7
realocation move 54 is executed on taxi trip 7
realocation move 57 is executed on taxi trip 7
realocation move 2 is executed on taxi trip 8
realocation move 8 is executed on taxi trip 8
realocation move 28 is executed on taxi trip 8
realocation move 31 is executed on taxi trip 8
realocation move 35 is executed on taxi trip 8
realocation move 42 is executed on taxi trip 8
```

```
realocation move 47 is executed on taxi trip 8
realocation move 55 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 170 nonzeros
Model fingerprint: 0x70bce905
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 590.8986539
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 1: 590.899

Optimal solution found (tolerance 1.00e-04)
Best objective 5.908986539231e+02, best bound 5.908986539231e+02, gap 0.0
000%
n_simulation=2 i=1
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2081 nonzeros
Model fingerprint: 0xbc54b96b
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [7e-02, 1e+02]
  Objective range  [1e+00, 7e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1036.3126221
Presolve removed 88 rows and 0 columns
Presolve time: 0.00s
Presolved: 521 rows, 558 columns, 1993 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.278236e+02, 790 iterations, 0.01 seconds (0.
```

```
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  327.82358    0  377 1036.31262  327.82358  68.4%     -     0
s
H    0     0                       695.7531650  327.82358  52.9%     -     0
s
H    0     0                       638.2199584  327.82358  48.6%     -     0
s
H    0     0                       616.4746346  327.82358  46.8%     -     0
s
H    0     0                       604.0386235  336.62139  44.3%     -     0
s
     0     0  336.62139    0  340  604.03862  336.62139  44.3%     -     0
s
H    0     0                       572.7242385  336.62139  41.2%     -     0
s
H    0     0                       570.6668617  336.62139  41.0%     -     0
s
     0     0  347.72939    0  358  570.66686  347.72939  39.1%     -     0
s
     0     0  349.09393    0  364  570.66686  349.09393  38.8%     -     0
s
     0     0  351.90753    0  364  570.66686  351.90753  38.3%     -     0
s
     0     0  351.90753    0  365  570.66686  351.90753  38.3%     -     0
s
     0     0  353.46008    0  365  570.66686  353.46008  38.1%     -     0
s
     0     0  361.96347    0  358  570.66686  361.96347  36.6%     -     0
s
     0     0  361.96347    0  357  570.66686  361.96347  36.6%     -     0
s
H    0     0                       540.7991240  361.96347  33.1%     -     0
s
     0     2  361.96347    0  355  540.79912  361.96347  33.1%     -     0
s
H   59    55                       539.1024295  361.96347  32.9%  83.2     0
s
H   67    55                       525.8615058  361.96347  31.2%  81.2     0
s
H  106   103                       524.7907178  361.96347  31.0%  64.5     0
s
H  144   139                       522.9034097  361.96347  30.8%  56.9     0
s
H  151   139                       522.7310280  361.96347  30.8%  55.1     0
s
H  173   175                       518.5261669  361.96347  30.2%  54.8     0
s
H  298   282                       515.5310770  361.96347  29.8%  43.0     0
s
H  621   516                       500.3808273  366.98893  26.7%  32.9     1
s
H  706   545                       498.5767950  368.59255  26.1%  34.5     1
```

```
s
H  843   624                     493.0016505  368.59255  25.2%  32.6    1
s
H 1100   775                     492.5260036  374.32536  24.0%  38.6    1
s
H 1127   766                     492.4472822  374.32536  24.0%  38.5    2
s
 13628  8863  440.13376   48  268  492.44728  385.03748  21.8%  31.6    5
s
 28985 17945  474.08296   77  357  492.44728  398.94492  19.0%  30.6   11
s
 29062 17996  466.87487   77  396  492.44728  398.94492  19.0%  30.5   15
s
 29141 18052  398.94492   28  389  492.44728  398.94492  19.0%  30.9   25
s
 29448 18222  411.42287   40  308  492.44728  398.94492  19.0%  32.1   30
s
 30681 18710  438.76826   89  235  492.44728  398.94492  19.0%  36.3   36
s
 31442 19033  462.90890  142  146  492.44728  398.94492  19.0%  39.0   40
s
 31921 19153  403.44617   34  353  492.44728  403.44617  18.1%  40.0   46
s
 32790 19463  426.14932   54  292  492.44728  405.43659  17.7%  43.1   50
s
 34410 20106  412.21827   46  303  492.44728  412.13936  16.3%  47.9   55
s
 35940 20421  466.97111   66  234  492.44728  414.81558  15.8%  51.4   60
s

Cutting planes:
  Gomory: 137
  Implied bound: 38
  Clique: 1
  MIR: 113
  Flow cover: 784
  RLT: 23
  Relax-and-lift: 217

Explored 36152 nodes (1882502 simplex iterations) in 60.02 seconds (74.00
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 492.447 492.526 493.002 ... 524.791

Time limit reached
Best objective 4.924472821903e+02, best bound 4.148155843625e+02, gap 15.
7645%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 2 is executed on taxi trip 0
realocation move 4 is executed on taxi trip 0
realocation move 9 is executed on taxi trip 0
realocation move 10 is executed on taxi trip 0
realocation move 17 is executed on taxi trip 0
```

```
realocation move 35 is executed on taxi trip 0
realocation move 45 is executed on taxi trip 0
realocation move 58 is executed on taxi trip 0
realocation move 8 is executed on taxi trip 1
realocation move 12 is executed on taxi trip 1
realocation move 15 is executed on taxi trip 1
realocation move 23 is executed on taxi trip 1
realocation move 38 is executed on taxi trip 1
realocation move 51 is executed on taxi trip 1
realocation move 53 is executed on taxi trip 1
realocation move 56 is executed on taxi trip 1
realocation move 7 is executed on taxi trip 3
realocation move 16 is executed on taxi trip 3
realocation move 21 is executed on taxi trip 3
realocation move 49 is executed on taxi trip 3
realocation move 52 is executed on taxi trip 3
realocation move 57 is executed on taxi trip 3
realocation move 59 is executed on taxi trip 3
realocation move 1 is executed on taxi trip 4
realocation move 3 is executed on taxi trip 4
realocation move 14 is executed on taxi trip 4
realocation move 18 is executed on taxi trip 4
realocation move 22 is executed on taxi trip 4
realocation move 30 is executed on taxi trip 4
realocation move 36 is executed on taxi trip 4
realocation move 48 is executed on taxi trip 4
realocation move 5 is executed on taxi trip 5
realocation move 6 is executed on taxi trip 5
realocation move 13 is executed on taxi trip 5
realocation move 19 is executed on taxi trip 5
realocation move 20 is executed on taxi trip 5
realocation move 27 is executed on taxi trip 5
realocation move 40 is executed on taxi trip 5
realocation move 43 is executed on taxi trip 5
realocation move 11 is executed on taxi trip 6
realocation move 26 is executed on taxi trip 6
realocation move 31 is executed on taxi trip 6
realocation move 32 is executed on taxi trip 6
realocation move 37 is executed on taxi trip 6
realocation move 41 is executed on taxi trip 6
realocation move 46 is executed on taxi trip 6
realocation move 54 is executed on taxi trip 6
realocation move 0 is executed on taxi trip 7
realocation move 24 is executed on taxi trip 7
realocation move 29 is executed on taxi trip 7
realocation move 34 is executed on taxi trip 7
realocation move 39 is executed on taxi trip 7
realocation move 47 is executed on taxi trip 7
realocation move 50 is executed on taxi trip 7
realocation move 55 is executed on taxi trip 7
realocation move 25 is executed on taxi trip 8
realocation move 28 is executed on taxi trip 8
realocation move 33 is executed on taxi trip 8
realocation move 42 is executed on taxi trip 8
realocation move 44 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
```

```
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 178 nonzeros
Model fingerprint: 0x58f30342
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 617.1446581
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 2: 570.632 617.145

Optimal solution found (tolerance 1.00e-04)
Best objective 5.706319331887e+02, best bound 5.706319331887e+02, gap 0.0
000%
n_simulation=2 i=2
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2115 nonzeros
Model fingerprint: 0xfb3199d8
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [5e-01, 1e+02]
  Objective range  [1e+00, 7e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 919.0098097
Presolve removed 54 rows and 0 columns
Presolve time: 0.00s
Presolved: 555 rows, 558 columns, 2061 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.463844e+02, 812 iterations, 0.01 seconds (0.
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
```

```
ime

     0      0  346.38444     0  378  919.00981  346.38444  62.3%      -     0
s
H    0      0                    603.6501726  346.38444  42.6%      -     0
s
H    0      0                    566.9539098  346.38444  38.9%      -     0
s
H    0      0                    545.8800746  346.38444  36.5%      -     0
s
     0      0  354.42951     0  382  545.88007  354.42951  35.1%      -     0
s
     0      0  362.60143     0  377  545.88007  362.60143  33.6%      -     0
s
     0      0  364.82875     0  377  545.88007  364.82875  33.2%      -     0
s
     0      0  364.82875     0  378  545.88007  364.82875  33.2%      -     0
s
H    0      0                    538.1381522  364.82875  32.2%      -     0
s
     0      0  380.40500     0  375  538.13815  380.40500  29.3%      -     0
s
     0      0  380.40500     0  375  538.13815  380.40500  29.3%      -     0
s
H    0      0                    505.0819619  380.40500  24.7%      -     0
s
     0      2  380.40500     0  375  505.08196  380.40500  24.7%      -     0
s
H  141    130                    503.1697575  385.20301  23.4%   63.6     0
s
H  642    521                    502.3819088  389.20613  22.5%   41.0     1
s
H 1156    826                    501.1594884  400.51932  20.1%   41.3     2
s
H 1678   1042                    499.7549171  400.51932  19.9%   37.2     3
s
 11579   8404  412.03648    92  249  499.75492  400.51932  19.9%   18.8     5
s
 29826  21085  498.24508    31  375  499.75492  400.51932  19.9%   13.8    10
s
 29875  21118  473.80639   100  397  499.75492  412.37875  17.5%   13.7    15
s
 29968  21180  451.79110   139  401  499.75492  412.87826  17.4%   13.7    20
s
 29993  21199  413.32823    25  381  499.75492  413.32823  17.3%   14.1    30
s
 30221  21325  424.25266    36  371  499.75492  417.76670  16.4%   14.9    35
s
 32664  22489  443.23425    81  280  499.75492  417.76670  16.4%   19.1    40
s
 35393  23360  462.38082   151  199  499.75492  417.76670  16.4%   22.7    50
s
 36551  23980  424.14279    41  331  499.75492  419.93680  16.0%   23.4    55
s
 39271  24633  433.70471    34  329  499.75492  427.55347  14.4%   25.5    60
s
H39282  23566                    499.7549166  427.55347  14.4%   25.5    60
```

```
s

Cutting planes:
  Gomory: 181
  Cover: 1
  Implied bound: 39
  MIR: 105
  Flow cover: 359
  RLT: 2
  Relax-and-lift: 289

Explored 39284 nodes (1003881 simplex iterations) in 60.02 seconds (73.99
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 499.755 499.755 501.159 ... 603.65

Time limit reached
Best objective 4.997549165898e+02, best bound 4.275534742174e+02, gap 14.
4474%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 4 is executed on taxi trip 0
realocation move 12 is executed on taxi trip 0
realocation move 26 is executed on taxi trip 0
realocation move 28 is executed on taxi trip 0
realocation move 52 is executed on taxi trip 0
realocation move 54 is executed on taxi trip 0
realocation move 56 is executed on taxi trip 0
realocation move 58 is executed on taxi trip 0
realocation move 0 is executed on taxi trip 1
realocation move 17 is executed on taxi trip 1
realocation move 20 is executed on taxi trip 1
realocation move 24 is executed on taxi trip 1
realocation move 37 is executed on taxi trip 1
realocation move 38 is executed on taxi trip 1
realocation move 45 is executed on taxi trip 1
realocation move 46 is executed on taxi trip 1
realocation move 1 is executed on taxi trip 2
realocation move 16 is executed on taxi trip 2
realocation move 22 is executed on taxi trip 2
realocation move 23 is executed on taxi trip 2
realocation move 25 is executed on taxi trip 2
realocation move 32 is executed on taxi trip 2
realocation move 36 is executed on taxi trip 2
realocation move 57 is executed on taxi trip 2
realocation move 7 is executed on taxi trip 3
realocation move 10 is executed on taxi trip 3
realocation move 11 is executed on taxi trip 3
realocation move 15 is executed on taxi trip 3
realocation move 33 is executed on taxi trip 3
realocation move 42 is executed on taxi trip 3
realocation move 51 is executed on taxi trip 3
realocation move 53 is executed on taxi trip 3
realocation move 3 is executed on taxi trip 4
```

```
realocation move 6 is executed on taxi trip 4
realocation move 8 is executed on taxi trip 4
realocation move 21 is executed on taxi trip 4
realocation move 27 is executed on taxi trip 4
realocation move 29 is executed on taxi trip 4
realocation move 30 is executed on taxi trip 4
realocation move 41 is executed on taxi trip 4
realocation move 2 is executed on taxi trip 5
realocation move 14 is executed on taxi trip 5
realocation move 39 is executed on taxi trip 5
realocation move 49 is executed on taxi trip 5
realocation move 9 is executed on taxi trip 6
realocation move 13 is executed on taxi trip 6
realocation move 31 is executed on taxi trip 6
realocation move 35 is executed on taxi trip 6
realocation move 40 is executed on taxi trip 6
realocation move 44 is executed on taxi trip 6
realocation move 50 is executed on taxi trip 6
realocation move 59 is executed on taxi trip 6
realocation move 5 is executed on taxi trip 7
realocation move 18 is executed on taxi trip 7
realocation move 19 is executed on taxi trip 7
realocation move 34 is executed on taxi trip 7
realocation move 43 is executed on taxi trip 7
realocation move 47 is executed on taxi trip 7
realocation move 48 is executed on taxi trip 7
realocation move 55 is executed on taxi trip 7
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 169 nonzeros
Model fingerprint: 0xebbc7ec1
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 694.9735400
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)
```

```
Solution count 1: 694.974

Optimal solution found (tolerance 1.00e-04)
Best objective 6.949735400423e+02, best bound 6.949735400423e+02, gap 0.0
000%
n_simulation=2 i=3
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2117 nonzeros
Model fingerprint: 0x39a3c03a
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [4e-02, 1e+02]
  Objective range  [1e+00, 6e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 951.0602933
Presolve removed 52 rows and 0 columns
Presolve time: 0.00s
Presolved: 557 rows, 558 columns, 2065 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.695782e+02, 819 iterations, 0.01 seconds (0.
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  369.57824    0  356  951.06029  369.57824  61.1%     -    0
s
H    0     0                     671.4231926  369.57824  45.0%     -    0
s
H    0     0                     598.3151026  369.57824  38.2%     -    0
s
H    0     0                     593.0075487  369.57824  37.7%     -    0
s
H    0     0                     591.7833520  399.47071  32.5%     -    0
s
     0     0  399.78112    0  395  591.78335  399.78112  32.4%     -    0
s
H    0     0                     586.4757980  399.78112  31.8%     -    0
s
     0     0  401.99730    0  380  586.47580  401.99730  31.5%     -    0
s
     0     0  402.26529    0  383  586.47580  402.26529  31.4%     -    0
s
     0     0  403.80431    0  386  586.47580  403.80431  31.1%     -    0
s
H    0     0                     585.9029602  403.80431  31.1%     -    0
s
     0     0  405.87188    0  366  585.90296  405.87188  30.7%     -    0
s
     0     0  406.02502    0  377  585.90296  406.02502  30.7%     -    0
s
```

```
      0      0  406.14882    0  377  585.90296  406.14882  30.7%      -     0
s
      0      0  406.15759    0  378  585.90296  406.15759  30.7%      -     0
s
H     0      0                    575.5504739  414.80037  27.9%      -     0
s
      0      0  417.31654    0  354  575.55047  417.31654  27.5%      -     0
s
      0      0  417.31654    0  354  575.55047  417.31654  27.5%      -     0
s
H     0      0                    564.5724721  417.31654  26.1%      -     0
s
      0      2  417.31654    0  354  564.57247  417.31654  26.1%      -     0
s
H    97    104                    560.1375958  418.21271  25.3%   89.4     1
s
H    98    104                    559.8435677  418.21271  25.3%   88.8     1
s
H   102    104                    558.9906503  418.21271  25.2%   88.8     1
s
H   352    333                    554.5557741  418.21271  24.6%   60.6     1
s
H   362    333                    554.4775926  418.21271  24.6%   62.9     1
s
H   389    355                    554.1835645  420.39160  24.1%   66.7     1
s
H   391    355                    553.9185309  420.39160  24.1%   67.0     1
s
H   557    489                    553.1450801  420.39160  24.0%   65.7     1
s
H   567    489                    552.8403786  420.39160  24.0%   64.9     1
s
H   682    554                    547.5902520  423.54194  22.7%   64.4     1
s
H  1103    858                    538.9611538  423.54194  21.4%   57.4     3
s
   1165    914  457.55401   19  357  538.96115  424.64697  21.2%   68.2     5
s
H  1221    899                    538.9611534  424.64697  21.2%   68.6     6
s
H  1268    891                    538.1877030  424.64697  21.1%   69.4     6
s
   3256   1707  532.88065   76  243  538.18770  424.64697  21.1%   74.2    10
s
   5822   3502  519.81935   42  265  538.18770  442.88493  17.7%   72.2    15
s
   8746   5732  532.27628   70  158  538.18770  447.61906  16.8%   75.9    20
s
  12742   8848  487.86997   26  288  538.18770  452.95787  15.8%   74.7    25
s
  16087  11381  505.63267  100  163  538.18770  454.05002  15.6%   75.3    30
s
  19817  14193  474.51186   33  274  538.18770  455.70131  15.3%   74.4    35
s
  23099  16218  508.89350   29  258  538.18770  456.54394  15.2%   73.9    40
s
  26579  18485  533.88317  107  179  538.18770  456.99544  15.1%   73.1    45
```

```
s

Cutting planes:
  Gomory: 70
  Cover: 2
  MIR: 37
  Flow cover: 515
  RLT: 45
  Relax-and-lift: 467

Explored 29189 nodes (2120147 simplex iterations) in 60.01 seconds (69.15
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 538.188 538.961 538.961 ... 554.556

Time limit reached
Best objective 5.381877030216e+02, best bound 4.573872192568e+02, gap 15.
0134%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 12 is executed on taxi trip 0
realocation move 16 is executed on taxi trip 0
realocation move 26 is executed on taxi trip 0
realocation move 28 is executed on taxi trip 0
realocation move 33 is executed on taxi trip 0
realocation move 37 is executed on taxi trip 0
realocation move 41 is executed on taxi trip 0
realocation move 43 is executed on taxi trip 0
realocation move 1 is executed on taxi trip 1
realocation move 6 is executed on taxi trip 1
realocation move 10 is executed on taxi trip 1
realocation move 21 is executed on taxi trip 1
realocation move 25 is executed on taxi trip 1
realocation move 32 is executed on taxi trip 1
realocation move 50 is executed on taxi trip 1
realocation move 53 is executed on taxi trip 1
realocation move 0 is executed on taxi trip 2
realocation move 11 is executed on taxi trip 2
realocation move 14 is executed on taxi trip 2
realocation move 17 is executed on taxi trip 2
realocation move 18 is executed on taxi trip 2
realocation move 29 is executed on taxi trip 2
realocation move 30 is executed on taxi trip 2
realocation move 51 is executed on taxi trip 2
realocation move 7 is executed on taxi trip 3
realocation move 20 is executed on taxi trip 3
realocation move 24 is executed on taxi trip 3
realocation move 35 is executed on taxi trip 3
realocation move 38 is executed on taxi trip 3
realocation move 52 is executed on taxi trip 3
realocation move 56 is executed on taxi trip 3
realocation move 59 is executed on taxi trip 3
realocation move 4 is executed on taxi trip 4
realocation move 5 is executed on taxi trip 4
```

```
realocation move 19 is executed on taxi trip 4
realocation move 23 is executed on taxi trip 4
realocation move 39 is executed on taxi trip 4
realocation move 44 is executed on taxi trip 4
realocation move 45 is executed on taxi trip 4
realocation move 48 is executed on taxi trip 4
realocation move 15 is executed on taxi trip 6
realocation move 49 is executed on taxi trip 6
realocation move 55 is executed on taxi trip 6
realocation move 58 is executed on taxi trip 6
realocation move 2 is executed on taxi trip 7
realocation move 8 is executed on taxi trip 7
realocation move 22 is executed on taxi trip 7
realocation move 31 is executed on taxi trip 7
realocation move 40 is executed on taxi trip 7
realocation move 47 is executed on taxi trip 7
realocation move 54 is executed on taxi trip 7
realocation move 57 is executed on taxi trip 7
realocation move 3 is executed on taxi trip 8
realocation move 9 is executed on taxi trip 8
realocation move 13 is executed on taxi trip 8
realocation move 27 is executed on taxi trip 8
realocation move 34 is executed on taxi trip 8
realocation move 36 is executed on taxi trip 8
realocation move 42 is executed on taxi trip 8
realocation move 46 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 165 nonzeros
Model fingerprint: 0x9412fbf2
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [7e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 756.0427153
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 2: 706.067 756.043
```

```
Optimal solution found (tolerance 1.00e-04)
Best objective 7.060671366021e+02, best bound 7.060671366021e+02, gap 0.0
000%
n_simulation=2 i=4
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 1841 nonzeros
Model fingerprint: 0xa32e55f3
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [3e-01, 1e+02]
  Objective range  [1e+00, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1054.4177334
Presolve removed 328 rows and 2 columns
Presolve time: 0.00s
Presolved: 281 rows, 556 columns, 1513 nonzeros
Variable types: 7 continuous, 549 integer (549 binary)

Root relaxation: objective 5.461244e+02, 387 iterations, 0.00 seconds (0.
00 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  546.12437    0  131 1054.41773  546.12437  48.2%     -    0
s
H    0     0                     743.1530593  546.12437  26.5%     -    0
s
H    0     0                     608.5981191  546.12437  10.3%     -    0
s
     0     0  600.54028    0   79  608.59812  600.54028  1.32%     -    0
s
H    0     0                     605.9450598  600.54028  0.89%     -    0
s
     0     0     cutoff    0       605.94506  605.94506  0.00%     -    0
s

Cutting planes:
  Gomory: 35
  Cover: 1
  Clique: 5
  MIR: 2
  RLT: 2
  Relax-and-lift: 4

Explored 1 nodes (707 simplex iterations) in 0.06 seconds (0.02 work unit
s)
Thread count was 8 (of 8 available processors)

Solution count 4: 605.945 608.598 743.153 1054.42
```

```
Optimal solution found (tolerance 1.00e-04)
Best objective 6.059450598201e+02, best bound 6.059450598201e+02, gap 0.0
000%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 6 is executed on taxi trip 0
realocation move 12 is executed on taxi trip 0
realocation move 38 is executed on taxi trip 0
realocation move 55 is executed on taxi trip 0
realocation move 4 is executed on taxi trip 1
realocation move 8 is executed on taxi trip 1
realocation move 15 is executed on taxi trip 1
realocation move 16 is executed on taxi trip 1
realocation move 17 is executed on taxi trip 1
realocation move 31 is executed on taxi trip 1
realocation move 36 is executed on taxi trip 1
realocation move 43 is executed on taxi trip 1
realocation move 3 is executed on taxi trip 2
realocation move 11 is executed on taxi trip 2
realocation move 14 is executed on taxi trip 2
realocation move 18 is executed on taxi trip 2
realocation move 25 is executed on taxi trip 2
realocation move 35 is executed on taxi trip 2
realocation move 42 is executed on taxi trip 2
realocation move 53 is executed on taxi trip 2
realocation move 2 is executed on taxi trip 4
realocation move 21 is executed on taxi trip 4
realocation move 22 is executed on taxi trip 4
realocation move 32 is executed on taxi trip 4
realocation move 34 is executed on taxi trip 4
realocation move 45 is executed on taxi trip 4
realocation move 46 is executed on taxi trip 4
realocation move 54 is executed on taxi trip 4
realocation move 9 is executed on taxi trip 5
realocation move 20 is executed on taxi trip 5
realocation move 26 is executed on taxi trip 5
realocation move 29 is executed on taxi trip 5
realocation move 30 is executed on taxi trip 5
realocation move 50 is executed on taxi trip 5
realocation move 52 is executed on taxi trip 5
realocation move 58 is executed on taxi trip 5
realocation move 1 is executed on taxi trip 6
realocation move 5 is executed on taxi trip 6
realocation move 10 is executed on taxi trip 6
realocation move 37 is executed on taxi trip 6
realocation move 41 is executed on taxi trip 6
realocation move 44 is executed on taxi trip 6
realocation move 49 is executed on taxi trip 6
realocation move 57 is executed on taxi trip 6
realocation move 0 is executed on taxi trip 7
realocation move 13 is executed on taxi trip 7
realocation move 19 is executed on taxi trip 7
realocation move 24 is executed on taxi trip 7
realocation move 27 is executed on taxi trip 7
realocation move 33 is executed on taxi trip 7
```

```
realocation move 39 is executed on taxi trip 7
realocation move 56 is executed on taxi trip 7
realocation move 7 is executed on taxi trip 8
realocation move 23 is executed on taxi trip 8
realocation move 28 is executed on taxi trip 8
realocation move 40 is executed on taxi trip 8
realocation move 47 is executed on taxi trip 8
realocation move 48 is executed on taxi trip 8
realocation move 51 is executed on taxi trip 8
realocation move 59 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 158 nonzeros
Model fingerprint: 0x80e974b6
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [7e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 573.3785681
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 1: 573.379

Optimal solution found (tolerance 1.00e-04)
Best objective 5.733785680584e+02, best bound 5.733785680584e+02, gap 0.0
000%
n_simulation=2 i=5
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 670 rows, 620 columns and 2360 nonzeros
Model fingerprint: 0x7bbffe47
Variable types: 10 continuous, 610 integer (610 binary)
Coefficient statistics:
  Matrix range     [2e-01, 1e+02]
  Objective range  [1e+00, 6e+01]
  Bounds range     [1e+00, 1e+00]
```

```
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1043.1556320
Presolve removed 50 rows and 0 columns
Presolve time: 0.00s
Presolved: 620 rows, 620 columns, 2310 nonzeros
Variable types: 10 continuous, 610 integer (610 binary)

Root relaxation: objective 3.077567e+02, 991 iterations, 0.01 seconds (0.
02 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  307.75674    0  372 1043.15563  307.75674  70.5%     -    0
s
H    0     0                       801.7916120  307.75674  61.6%     -    0
s
H    0     0                       742.5055331  307.75674  58.6%     -    0
s
H    0     0                       649.2805039  307.75674  52.6%     -    0
s
H    0     0                       585.6502336  307.75674  47.5%     -    0
s
     0     0  316.25092    0  374  585.65023  316.25092  46.0%     -    0
s
H    0     0                       561.3292071  316.25092  43.7%     -    0
s
     0     0  321.29574    0  392  561.32921  321.29574  42.8%     -    0
s
     0     0  321.61232    0  387  561.32921  321.61232  42.7%     -    0
s
     0     0  321.77793    0  380  561.32921  321.77793  42.7%     -    0
s
     0     0  321.93690    0  389  561.32921  321.93690  42.6%     -    0
s
     0     0  321.97292    0  389  561.32921  321.97292  42.6%     -    0
s
     0     0  322.17256    0  389  561.32921  322.17256  42.6%     -    0
s
     0     0  325.73083    0  413  561.32921  325.73083  42.0%     -    0
s
H    0     0                       556.6300928  325.73083  41.5%     -    0
s
     0     0  325.73083    0  413  556.63009  325.73083  41.5%     -    0
s
H    0     0                       542.9689656  325.73083  40.0%     -    0
s
H    0     2                       533.4199601  325.73083  38.9%     -    0
s
     0     2  325.73083    0  413  533.41996  325.73083  38.9%     -    0
s
H   28    24                       531.7957460  328.68505  38.2%   170    0
s
H   29    24                       529.9189606  328.68505  38.0%   181    0
s
H  260   256                       529.0111433  328.68505  37.9%  86.6    1
```

```
s
H  267   256                      520.7284647  328.68505  36.9%  84.9    1
s
H  296   294                      520.2837743  328.68505  36.8%  81.0    1
s
H  356   325                      514.4044903  328.68505  36.1%  74.4    1
s
H  386   332                      507.6374846  329.93841  35.0%  77.1    2
s
H  850   697                      507.4558957  331.15231  34.7%  61.1    2
s
  1089   861  419.58951   23  461  507.45590  339.02747  33.2%  56.6    5
s
H 1214   903                      507.4558890  345.64548  31.9%  76.6    9
s
  1517  1084  383.80833   25  349  507.45589  345.64548  31.9%  83.6   10
s
H 1559  1033                      507.2167995  345.64548  31.9%  85.2   12
s
H 1997  1176                      505.0145179  345.64548  31.6%  94.9   13
s
  2352  1366  462.98416   47  256  505.01452  345.64548  31.6%   101   15
s
  4334  2405  490.74843   57  220  505.01452  364.16733  27.9%   100   20
s
  6352  3993     cutoff   78       505.01452  370.57934  26.6%   101   25
s
H 6525  3927                      503.0006942  370.57934  26.3%   102   26
s
  8211  5423  501.84385   82  189  503.00069  372.61888  25.9%   101   30
s
H 9727  6355                      501.8523811  378.99659  24.5%  98.1   33
s
 10366  6910  382.76124   30  312  501.85238  379.33197  24.4%  97.8   35
s
 12419  8384  432.28301   39  250  501.85238  383.46181  23.6%   101   41
s
 14226  9753  433.19486   48  239  501.85238  385.88945  23.1%   103   45
s
 15379 10319  400.75790   29  281  501.85238  386.64578  23.0%   103   58
s
 15989 10966  477.61744   46  222  501.85238  387.42271  22.8%   103   60
s

Cutting planes:
  Gomory: 81
  Cover: 2
  Clique: 1
  MIR: 67
  Flow cover: 1233
  Inf proof: 1
  RLT: 20
  Relax-and-lift: 227

Explored 16308 nodes (1685164 simplex iterations) in 60.02 seconds (76.53
work units)
Thread count was 8 (of 8 available processors)
```

```
Solution count 10: 501.852 503.001 505.015 ... 520.728

Time limit reached
Best objective 5.018523810901e+02, best bound 3.875166711474e+02, gap 22.
7827%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 3 is executed on taxi trip 0
realocation move 9 is executed on taxi trip 0
realocation move 20 is executed on taxi trip 0
realocation move 27 is executed on taxi trip 0
realocation move 29 is executed on taxi trip 0
realocation move 37 is executed on taxi trip 0
realocation move 45 is executed on taxi trip 0
realocation move 57 is executed on taxi trip 0
realocation move 4 is executed on taxi trip 1
realocation move 8 is executed on taxi trip 1
realocation move 10 is executed on taxi trip 1
realocation move 13 is executed on taxi trip 1
realocation move 16 is executed on taxi trip 1
realocation move 33 is executed on taxi trip 1
realocation move 46 is executed on taxi trip 1
realocation move 50 is executed on taxi trip 1
realocation move 0 is executed on taxi trip 2
realocation move 22 is executed on taxi trip 2
realocation move 36 is executed on taxi trip 2
realocation move 53 is executed on taxi trip 2
realocation move 17 is executed on taxi trip 5
realocation move 21 is executed on taxi trip 5
realocation move 32 is executed on taxi trip 5
realocation move 41 is executed on taxi trip 5
realocation move 42 is executed on taxi trip 5
realocation move 49 is executed on taxi trip 5
realocation move 51 is executed on taxi trip 5
realocation move 52 is executed on taxi trip 5
realocation move 1 is executed on taxi trip 6
realocation move 2 is executed on taxi trip 6
realocation move 6 is executed on taxi trip 6
realocation move 12 is executed on taxi trip 6
realocation move 18 is executed on taxi trip 6
realocation move 28 is executed on taxi trip 6
realocation move 34 is executed on taxi trip 6
realocation move 35 is executed on taxi trip 6
realocation move 5 is executed on taxi trip 7
realocation move 7 is executed on taxi trip 7
realocation move 14 is executed on taxi trip 7
realocation move 15 is executed on taxi trip 7
realocation move 38 is executed on taxi trip 7
realocation move 40 is executed on taxi trip 7
realocation move 54 is executed on taxi trip 7
realocation move 58 is executed on taxi trip 7
realocation move 19 is executed on taxi trip 8
realocation move 23 is executed on taxi trip 8
realocation move 24 is executed on taxi trip 8
```

```
realocation move 25 is executed on taxi trip 8
realocation move 26 is executed on taxi trip 8
realocation move 31 is executed on taxi trip 8
realocation move 39 is executed on taxi trip 8
realocation move 47 is executed on taxi trip 8
realocation move 11 is executed on taxi trip 9
realocation move 30 is executed on taxi trip 9
realocation move 43 is executed on taxi trip 9
realocation move 44 is executed on taxi trip 9
realocation move 48 is executed on taxi trip 9
realocation move 55 is executed on taxi trip 9
realocation move 56 is executed on taxi trip 9
realocation move 59 is executed on taxi trip 9
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
taxi trip 9 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 10 columns and 187 nonzeros
Model fingerprint: 0x34e1efbe
Variable types: 0 continuous, 10 integer (10 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 555.8285013
Presolve removed 60 rows and 10 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 2: 480.139 555.829

Optimal solution found (tolerance 1.00e-04)
Best objective 4.801391468457e+02, best bound 4.801391468457e+02, gap 0.0
000%
n_simulation=2 i=6
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2081 nonzeros
Model fingerprint: 0xbcb251e0
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
```

```
  Matrix range     [4e-02, 1e+02]
  Objective range  [1e+00, 7e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 957.9314655
Presolve removed 88 rows and 0 columns
Presolve time: 0.00s
Presolved: 521 rows, 558 columns, 1993 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.650120e+02, 857 iterations, 0.01 seconds (0.
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  365.01203    0  367  957.93147  365.01203  61.9%     -    0
s
H    0     0                       635.0664921  365.01203  42.5%     -    0
s
H    0     0                       620.4324394  365.01203  41.2%     -    0
s
H    0     0                       608.7637567  365.01203  40.0%     -    0
s
     0     0  377.25885    0  329  608.76376  377.25885  38.0%     -    0
s
H    0     0                       607.6112884  377.25885  37.9%     -    0
s
     0     0  381.91618    0  315  607.61129  381.91618  37.1%     -    0
s
     0     0  381.91618    0  315  607.61129  381.91618  37.1%     -    0
s
H    0     0                       587.2214980  399.92048  31.9%     -    0
s
     0     0  399.92048    0  365  587.22150  399.92048  31.9%     -    0
s
     0     0  399.92048    0  364  587.22150  399.92048  31.9%     -    0
s
H    0     0                       531.3413854  399.92048  24.7%     -    0
s
     0     2  399.92048    0  337  531.34139  399.92048  24.7%     -    0
s
H   75    71                       530.2809342  418.21385  21.1%  88.9    0
s
H  102   113                       528.7040210  418.21385  20.9%  82.3    0
s
H  191   185                       527.4403271  418.21385  20.7%  54.1    0
s
H  200   185                       526.5631748  418.21385  20.6%  53.0    0
s
H  442   349                       526.1422424  418.21385  20.5%  42.4    0
s
H 1005   775                       524.9556262  430.36763  18.0%  35.5    1
s
H 1029   752                       523.6228754  430.36763  17.8%  36.4    2
s
```

```
H 1102   760                    523.2868361  430.36763  17.8%  38.7    2
s
H 1154   753                    522.9879986  430.36763  17.7%  39.0    2
s
H 1163   716                    522.5650664  430.36763  17.6%  38.8    2
s
H 1204   706                    522.3680305  430.36763  17.6%  39.0    2
s
H 1208   673                    518.8274571  430.36763  17.0%  38.9    2
s
H 1354   709                    518.1641107  430.36763  16.9%  38.0    2
s
H 1360   679                    517.9651248  430.36763  16.9%  38.1    2
s
H 4150  2178                    517.4428590  430.36763  16.8%  34.1    3
s
H 4536  2210                    515.1373462  430.36763  16.5%  32.9    3
s
H 4683  2221                    513.9213197  430.36763  16.3%  33.1    3
s
H 4687  2207                    513.7733946  430.36763  16.2%  33.1    3
s
H 4692  2197                    513.5767689  430.36763  16.2%  33.2    3
s
 11478  6667  501.20426   66  218  513.57677  438.62817  14.6%  29.5    5
s
H18208  9947                    512.0351023  443.90750  13.3%  28.2    6
s
H18209  9445                    510.1750285  443.90750  13.0%  28.2    6
s
H18213  9366                    509.8389892  443.90750  12.9%  28.2    6
s
 29668 15758  499.96027   65  364  509.83899  448.27328  12.1%  28.0   14
s
 29678 15765  501.42585   75  355  509.83899  448.27328  12.1%  28.0   15
s
H29749 15020                    509.4451093  448.27328  12.0%  27.9   18
s
 29783 15046  448.27328   26  370  509.44511  448.27328  12.0%  28.2   21
s
 29854 15101  463.10874   32  229  509.44511  448.27328  12.0%  28.9   25
s
H30218 14472                    509.4451087  448.27328  12.0%  29.8   26
s
 31293 14956  449.06419   37  328  509.44511  448.27328  12.0%  31.7   30
s
 33226 15633  480.18948   40  239  509.44511  449.21625  11.8%  35.2   35
s
 35369 16382  464.68161   55  210  509.44511  452.47829  11.2%  38.2   44
s
 35902 16358  474.60488   90  161  509.44511  452.47829  11.2%  38.8   52
s
 36985 17040  472.12350   49  239  509.44511  454.02681  10.9%  39.7   55
s
 39154 17434  471.86707   58  266  509.44511  455.01466  10.7%  41.8   60
s
```

```
Cutting planes:
  Gomory: 80
  Cover: 2
  Implied bound: 91
  MIR: 83
  StrongCG: 1
  Flow cover: 458
  RLT: 29
  Relax-and-lift: 285

Explored 39188 nodes (1642338 simplex iterations) in 60.02 seconds (69.52
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 509.445 509.445 509.839 ... 517.443

Time limit reached
Best objective 5.094451086820e+02, best bound 4.550146648033e+02, gap 10.
6843%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 3 is executed on taxi trip 0
realocation move 14 is executed on taxi trip 0
realocation move 23 is executed on taxi trip 0
realocation move 24 is executed on taxi trip 0
realocation move 34 is executed on taxi trip 0
realocation move 48 is executed on taxi trip 0
realocation move 56 is executed on taxi trip 0
realocation move 58 is executed on taxi trip 0
realocation move 0 is executed on taxi trip 1
realocation move 7 is executed on taxi trip 1
realocation move 15 is executed on taxi trip 1
realocation move 17 is executed on taxi trip 1
realocation move 18 is executed on taxi trip 1
realocation move 21 is executed on taxi trip 1
realocation move 42 is executed on taxi trip 1
realocation move 44 is executed on taxi trip 1
realocation move 6 is executed on taxi trip 3
realocation move 10 is executed on taxi trip 3
realocation move 22 is executed on taxi trip 3
realocation move 28 is executed on taxi trip 3
realocation move 40 is executed on taxi trip 3
realocation move 43 is executed on taxi trip 3
realocation move 53 is executed on taxi trip 3
realocation move 59 is executed on taxi trip 3
realocation move 1 is executed on taxi trip 4
realocation move 11 is executed on taxi trip 4
realocation move 12 is executed on taxi trip 4
realocation move 35 is executed on taxi trip 4
realocation move 38 is executed on taxi trip 4
realocation move 49 is executed on taxi trip 4
realocation move 50 is executed on taxi trip 4
realocation move 51 is executed on taxi trip 4
realocation move 32 is executed on taxi trip 5
realocation move 36 is executed on taxi trip 5
```

```
realocation move 41 is executed on taxi trip 5
realocation move 47 is executed on taxi trip 5
realocation move 4 is executed on taxi trip 6
realocation move 9 is executed on taxi trip 6
realocation move 13 is executed on taxi trip 6
realocation move 16 is executed on taxi trip 6
realocation move 19 is executed on taxi trip 6
realocation move 20 is executed on taxi trip 6
realocation move 27 is executed on taxi trip 6
realocation move 52 is executed on taxi trip 6
realocation move 5 is executed on taxi trip 7
realocation move 8 is executed on taxi trip 7
realocation move 30 is executed on taxi trip 7
realocation move 31 is executed on taxi trip 7
realocation move 33 is executed on taxi trip 7
realocation move 37 is executed on taxi trip 7
realocation move 45 is executed on taxi trip 7
realocation move 57 is executed on taxi trip 7
realocation move 2 is executed on taxi trip 8
realocation move 25 is executed on taxi trip 8
realocation move 26 is executed on taxi trip 8
realocation move 29 is executed on taxi trip 8
realocation move 39 is executed on taxi trip 8
realocation move 46 is executed on taxi trip 8
realocation move 54 is executed on taxi trip 8
realocation move 55 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 170 nonzeros
Model fingerprint: 0x0d1db08e
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 630.7620879
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 1: 630.762
```

```
Optimal solution found (tolerance 1.00e-04)
Best objective 6.307620879438e+02, best bound 6.307620879438e+02, gap 0.0
000%
n_simulation=2 i=7
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 1800 nonzeros
Model fingerprint: 0xe0d293e6
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [2e-01, 7e+01]
  Objective range  [1e+00, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1016.5037817
Presolve removed 369 rows and 1 columns
Presolve time: 0.00s
Presolved: 240 rows, 557 columns, 1431 nonzeros
Variable types: 8 continuous, 549 integer (549 binary)

Root relaxation: objective 6.584167e+02, 228 iterations, 0.00 seconds (0.
00 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  658.41667    0    1 1016.50378  658.41667  35.2%     -    0
s
H    0     0                     715.8333333  658.41667  8.02%     -    0
s
     0     0     cutoff    0       715.83333  715.83333  0.00%     -    0
s

Cutting planes:
  Gomory: 1
  Cover: 1
  Clique: 3
  MIR: 1

Explored 1 nodes (231 simplex iterations) in 0.02 seconds (0.00 work unit
s)
Thread count was 8 (of 8 available processors)

Solution count 2: 715.833 1016.5

Optimal solution found (tolerance 1.00e-04)
Best objective 7.158333333333e+02, best bound 7.158333333333e+02, gap 0.0
000%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 1 is executed on taxi trip 1
```

```
realocation move 16 is executed on taxi trip 1
realocation move 25 is executed on taxi trip 1
realocation move 28 is executed on taxi trip 1
realocation move 29 is executed on taxi trip 1
realocation move 37 is executed on taxi trip 1
realocation move 38 is executed on taxi trip 1
realocation move 40 is executed on taxi trip 1
realocation move 3 is executed on taxi trip 2
realocation move 5 is executed on taxi trip 2
realocation move 9 is executed on taxi trip 2
realocation move 14 is executed on taxi trip 2
realocation move 18 is executed on taxi trip 2
realocation move 23 is executed on taxi trip 2
realocation move 30 is executed on taxi trip 2
realocation move 52 is executed on taxi trip 2
realocation move 10 is executed on taxi trip 3
realocation move 13 is executed on taxi trip 3
realocation move 19 is executed on taxi trip 3
realocation move 27 is executed on taxi trip 3
realocation move 33 is executed on taxi trip 3
realocation move 47 is executed on taxi trip 3
realocation move 48 is executed on taxi trip 3
realocation move 53 is executed on taxi trip 3
realocation move 7 is executed on taxi trip 4
realocation move 22 is executed on taxi trip 4
realocation move 35 is executed on taxi trip 4
realocation move 41 is executed on taxi trip 4
realocation move 42 is executed on taxi trip 4
realocation move 51 is executed on taxi trip 4
realocation move 54 is executed on taxi trip 4
realocation move 56 is executed on taxi trip 4
realocation move 20 is executed on taxi trip 5
realocation move 26 is executed on taxi trip 5
realocation move 31 is executed on taxi trip 5
realocation move 39 is executed on taxi trip 5
realocation move 44 is executed on taxi trip 5
realocation move 46 is executed on taxi trip 5
realocation move 49 is executed on taxi trip 5
realocation move 59 is executed on taxi trip 5
realocation move 2 is executed on taxi trip 6
realocation move 8 is executed on taxi trip 6
realocation move 17 is executed on taxi trip 6
realocation move 21 is executed on taxi trip 6
realocation move 24 is executed on taxi trip 6
realocation move 34 is executed on taxi trip 6
realocation move 36 is executed on taxi trip 6
realocation move 57 is executed on taxi trip 6
realocation move 6 is executed on taxi trip 7
realocation move 11 is executed on taxi trip 7
realocation move 12 is executed on taxi trip 7
realocation move 15 is executed on taxi trip 7
realocation move 32 is executed on taxi trip 7
realocation move 43 is executed on taxi trip 7
realocation move 45 is executed on taxi trip 7
realocation move 50 is executed on taxi trip 7
realocation move 0 is executed on taxi trip 8
realocation move 4 is executed on taxi trip 8
```

```
realocation move 55 is executed on taxi trip 8
realocation move 58 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 157 nonzeros
Model fingerprint: 0x0ef17ec4
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [9e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 832.7164640
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 2: 661.71 832.716

Optimal solution found (tolerance 1.00e-04)
Best objective 6.617101149641e+02, best bound 6.617101149641e+02, gap 0.0
000%
n_simulation=2 i=8
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2109 nonzeros
Model fingerprint: 0x6c6380d0
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [2e-01, 1e+02]
  Objective range  [1e+00, 6e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1032.0801492
Presolve removed 60 rows and 0 columns
Presolve time: 0.00s
Presolved: 549 rows, 558 columns, 2049 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 3.026132e+02, 751 iterations, 0.01 seconds (0.
```

```
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  302.61320    0  392 1032.08015  302.61320  70.7%     -    0
s
H    0     0                       620.9740749  302.61320  51.3%     -    0
s
H    0     0                       612.3147057  302.61320  50.6%     -    0
s
     0     0  310.40757    0  389  612.31471  310.40757  49.3%     -    0
s
     0     0  314.28780    0  380  612.31471  314.28780  48.7%     -    0
s
     0     0  315.64508    0  385  612.31471  315.64508  48.5%     -    0
s
     0     0  316.40393    0  383  612.31471  316.40393  48.3%     -    0
s
     0     0  316.88936    0  384  612.31471  316.88936  48.2%     -    0
s
     0     0  317.06305    0  384  612.31471  317.06305  48.2%     -    0
s
     0     0  317.15347    0  388  612.31471  317.15347  48.2%     -    0
s
     0     0  317.22429    0  387  612.31471  317.22429  48.2%     -    0
s
     0     0  317.42090    0  388  612.31471  317.42090  48.2%     -    0
s
     0     0  319.90258    0  391  612.31471  319.90258  47.8%     -    0
s
     0     0  321.31519    0  394  612.31471  321.31519  47.5%     -    0
s
     0     0  321.31519    0  394  612.31471  321.31519  47.5%     -    0
s
H    0     0                       599.3786487  321.31519  46.4%     -    0
s
     0     0  329.65222    0  386  599.37865  329.65222  45.0%     -    0
s
     0     0  329.65222    0  386  599.37865  329.65222  45.0%     -    0
s
H    0     0                       542.8775809  329.65222  39.3%     -    0
s
H    0     2                       541.7468215  329.65222  39.2%     -    0
s
     0     2  329.65222    0  386  541.74682  329.65222  39.2%     -    0
s
H   67    54                       540.3095757  329.65222  39.0%  91.7    0
s
H   94    78                       537.8643016  329.65222  38.7%   114    0
s
H  129   118                       537.4142413  329.65222  38.7%   121    0
s
H  151   153                       536.4194443  329.65222  38.5%   117    0
s
H  202   188                       533.3053214  329.65222  38.2%  95.0    0
```

```
s
H  207   192                      529.9982701  329.65222  37.8%  93.7    1
s
  1046   809 infeasible   14        529.99827  341.60876  35.5%  60.5    5
s
H 2064  1242                      527.6556483  344.00287  34.8%  85.3    8
s
  2875  1640  387.54731   31  277  527.65565  344.47050  34.7%  84.3   10
s
H 3750  1986                      527.6338338  349.43033  33.8%  80.8   12
s
  5382  3337  418.70656   29  319  527.63383  361.25305  31.5%  81.4   15
s
  8345  5580  479.44959   59  241  527.63383  375.52499  28.8%  81.3   20
s
 12295  8729  463.37915   51  282  527.63383  384.21427  27.2%  78.1   25
s
 15934 11181  465.32945   38  237  527.63383  388.24767  26.4%  79.0   30
s
H17104 11819                      527.6338332  389.24581  26.2%  79.1   32
s
H17187 11819                      527.6338325  389.24581  26.2%  79.1   32
s
 17545 12021  412.21730   25  300  527.63383  389.93358  26.1%  79.4   42
s
 19114 13667  481.59288   48  231  527.63383  391.40758  25.8%  79.3   45
s
 22714 16168  460.18263   57  229  527.63383  394.60706  25.2%  78.9   50
s
 27133 19223  426.29668   47  148  527.63383  397.11616  24.7%  78.7   55
s

Cutting planes:
  Gomory: 110
  Cover: 1
  MIR: 30
  Flow cover: 590
  Inf proof: 1
  RLT: 30
  Relax-and-lift: 219

Explored 29606 nodes (2323047 simplex iterations) in 60.02 seconds (73.85
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 527.634 527.634 527.656 ... 541.747

Time limit reached
Best objective 5.276337977034e+02, best bound 3.978400823069e+02, gap 24.
5992%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 0 is executed on taxi trip 0
realocation move 1 is executed on taxi trip 0
realocation move 11 is executed on taxi trip 0
```

```
realocation move 20 is executed on taxi trip 0
realocation move 31 is executed on taxi trip 0
realocation move 37 is executed on taxi trip 0
realocation move 38 is executed on taxi trip 0
realocation move 45 is executed on taxi trip 0
realocation move 6 is executed on taxi trip 2
realocation move 15 is executed on taxi trip 2
realocation move 21 is executed on taxi trip 2
realocation move 27 is executed on taxi trip 2
realocation move 46 is executed on taxi trip 2
realocation move 49 is executed on taxi trip 2
realocation move 54 is executed on taxi trip 2
realocation move 58 is executed on taxi trip 2
realocation move 10 is executed on taxi trip 3
realocation move 12 is executed on taxi trip 3
realocation move 14 is executed on taxi trip 3
realocation move 16 is executed on taxi trip 3
realocation move 18 is executed on taxi trip 3
realocation move 30 is executed on taxi trip 3
realocation move 42 is executed on taxi trip 3
realocation move 55 is executed on taxi trip 3
realocation move 22 is executed on taxi trip 4
realocation move 24 is executed on taxi trip 4
realocation move 28 is executed on taxi trip 4
realocation move 36 is executed on taxi trip 4
realocation move 40 is executed on taxi trip 4
realocation move 57 is executed on taxi trip 4
realocation move 5 is executed on taxi trip 5
realocation move 9 is executed on taxi trip 5
realocation move 32 is executed on taxi trip 5
realocation move 47 is executed on taxi trip 5
realocation move 8 is executed on taxi trip 6
realocation move 13 is executed on taxi trip 6
realocation move 39 is executed on taxi trip 6
realocation move 44 is executed on taxi trip 6
realocation move 51 is executed on taxi trip 6
realocation move 53 is executed on taxi trip 6
realocation move 59 is executed on taxi trip 6
realocation move 2 is executed on taxi trip 7
realocation move 7 is executed on taxi trip 7
realocation move 17 is executed on taxi trip 7
realocation move 29 is executed on taxi trip 7
realocation move 34 is executed on taxi trip 7
realocation move 35 is executed on taxi trip 7
realocation move 43 is executed on taxi trip 7
realocation move 48 is executed on taxi trip 7
realocation move 4 is executed on taxi trip 8
realocation move 23 is executed on taxi trip 8
realocation move 25 is executed on taxi trip 8
realocation move 50 is executed on taxi trip 8
realocation move 56 is executed on taxi trip 8
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
```

```
taxi trip 5 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 190 nonzeros
Model fingerprint: 0xfb0302bf
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [5e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 526.9114564
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 1: 526.911

Optimal solution found (tolerance 1.00e-04)
Best objective 5.269114563742e+02, best bound 5.269114563742e+02, gap 0.0
000%
n_simulation=2 i=9
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 609 rows, 558 columns and 2119 nonzeros
Model fingerprint: 0x2506e04a
Variable types: 9 continuous, 549 integer (549 binary)
Coefficient statistics:
  Matrix range     [5e-01, 1e+02]
  Objective range  [1e+00, 7e+01]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 1053.8684901
Presolve removed 50 rows and 0 columns
Presolve time: 0.00s
Presolved: 559 rows, 558 columns, 2069 nonzeros
Variable types: 9 continuous, 549 integer (549 binary)

Root relaxation: objective 2.986399e+02, 814 iterations, 0.01 seconds (0.
01 work units)

    Nodes    |    Current Node    |     Objective Bounds      |     Work
 Expl Unexpl |  Obj  Depth IntInf | Incumbent    BestBd   Gap | It/Node T
ime

     0     0  298.63988    0  394 1053.86849  298.63988  71.7%     -    0
s
```

```
H    0     0                    788.3247651  298.63988  62.1%      -    0
s
H    0     0                    636.0996381  298.63988  53.1%      -    0
s
     0     0  310.17084    0  405  636.09964  310.17084  51.2%      -    0
s
     0     0  318.44520    0  379  636.09964  318.44520  49.9%      -    0
s
     0     0  319.47331    0  379  636.09964  319.47331  49.8%      -    0
s
H    0     0                    615.0473972  319.47331  48.1%      -    0
s
     0     0  334.42473    0  402  615.04740  334.42473  45.6%      -    0
s
     0     0  334.64408    0  402  615.04740  334.64408  45.6%      -    0
s
H    0     0                    601.9594379  334.64408  44.4%      -    0
s
H    0     2                    600.5384753  334.64408  44.3%      -    0
s
     0     2  334.64408    0  402  600.53848  334.64408  44.3%      -    0
s
H   35    21                    591.6366328  334.64408  43.4%   85.9    0
s
H  103    86                    591.3112428  334.64408  43.4%   66.1    0
s
H  139   127                    589.7239516  334.64408  43.3%   62.1    0
s
H  140   127                    585.6084570  334.64408  42.9%   61.9    0
s
H  141   127                    584.7482484  334.64408  42.8%   62.5    0
s
H  310   318                    583.4956688  334.64408  42.6%   43.7    0
s
H  324   318                    582.1317671  334.64408  42.5%   42.1    0
s
H  330   318                    578.9895681  334.64408  42.2%   41.6    0
s
H 1001   812                    577.3184530  334.64408  42.0%   24.9    1
s
H 1006   801                    569.2575559  334.64408  41.2%   25.1    1
s
H 1015   795                    567.3265208  334.64408  41.0%   25.1    1
s
H 1150   844                    564.5020077  344.52399  39.0%   35.2    4
s
  1172   870  348.37479   24  315  564.50201  344.52399  39.0%   36.0    5
s
  1793  1164  399.44407   42  268  564.50201  344.52399  39.0%   53.3   10
s
  4075  2441  373.02546   21  328  564.50201  354.68190  37.2%   63.0   15
s
  6984  4918  458.84897   41  254  564.50201  374.83855  33.6%   63.9   20
s
H 7630  4422                    551.2389826  378.61104  31.3%   62.5   22
s
  8934  5668  419.11981   33  264  551.23898  379.94570  31.1%   61.0   25
```

```
s
 12362  8539  486.33493   97  179  551.23898  385.56607  30.1%  61.1   30
s
 15165 10562  419.03389   34  287  551.23898  387.39490  29.7%  61.5   35
s
 18174 13049  487.36655   65  196  551.23898  388.45577  29.5%  64.7   40
s
 21351 14695  434.14259   34  276  551.23898  391.14008  29.0%  62.4   45
s
H21366 14626                      550.6996098  391.14008  29.0%  62.4   45
s
H21384 14269                      548.3468508  391.14008  28.7%  62.4   45
s
H21485 14151                      547.6995026  391.14008  28.6%  62.4   45
s
H21503 13425                      543.7188646  391.14008  28.1%  62.4   54
s
H21506 12515                      539.0293252  391.14008  27.4%  62.4   54
s
 21511 12766     cutoff   49        539.02933  391.25805  27.4%  62.4   57
s
H21515 12248                      535.4127229  391.25805  26.9%  62.4   57
s
H21592 12138                      534.5917006  391.35502  26.8%  62.4   57
s
H21864 12066                      534.1262942  391.39277  26.7%  62.3   57
s
 23541 13425  454.60220   65  234  534.12629  392.32772  26.5%  62.5   60
s
H23542 13213                      532.7053316  392.32772  26.4%  62.5   60
s

Cutting planes:
  Gomory: 169
  Cover: 1
  MIR: 37
  Flow cover: 377
  Inf proof: 1
  RLT: 20
  Relax-and-lift: 238

Explored 23565 nodes (1473507 simplex iterations) in 60.02 seconds (71.13
work units)
Thread count was 8 (of 8 available processors)

Solution count 10: 532.705 534.126 534.592 ... 551.239

Time limit reached
Best objective 5.327053315759e+02, best bound 3.923277175677e+02, gap 26.
3518%

Solution
Binary variables: 1, if relocation move j in J is executed on taxi trip i
in I;0, otherwise
realocation move 28 is executed on taxi trip 0
realocation move 38 is executed on taxi trip 0
realocation move 42 is executed on taxi trip 0
```

```
realocation move 54 is executed on taxi trip 0
realocation move 6 is executed on taxi trip 1
realocation move 9 is executed on taxi trip 1
realocation move 11 is executed on taxi trip 1
realocation move 12 is executed on taxi trip 1
realocation move 25 is executed on taxi trip 1
realocation move 35 is executed on taxi trip 1
realocation move 49 is executed on taxi trip 1
realocation move 55 is executed on taxi trip 1
realocation move 3 is executed on taxi trip 2
realocation move 27 is executed on taxi trip 2
realocation move 43 is executed on taxi trip 2
realocation move 44 is executed on taxi trip 2
realocation move 47 is executed on taxi trip 2
realocation move 50 is executed on taxi trip 2
realocation move 51 is executed on taxi trip 2
realocation move 59 is executed on taxi trip 2
realocation move 2 is executed on taxi trip 3
realocation move 7 is executed on taxi trip 3
realocation move 13 is executed on taxi trip 3
realocation move 16 is executed on taxi trip 3
realocation move 22 is executed on taxi trip 3
realocation move 29 is executed on taxi trip 3
realocation move 41 is executed on taxi trip 3
realocation move 48 is executed on taxi trip 3
realocation move 0 is executed on taxi trip 4
realocation move 4 is executed on taxi trip 4
realocation move 10 is executed on taxi trip 4
realocation move 19 is executed on taxi trip 4
realocation move 30 is executed on taxi trip 4
realocation move 31 is executed on taxi trip 4
realocation move 37 is executed on taxi trip 4
realocation move 52 is executed on taxi trip 4
realocation move 17 is executed on taxi trip 6
realocation move 18 is executed on taxi trip 6
realocation move 20 is executed on taxi trip 6
realocation move 24 is executed on taxi trip 6
realocation move 36 is executed on taxi trip 6
realocation move 40 is executed on taxi trip 6
realocation move 46 is executed on taxi trip 6
realocation move 53 is executed on taxi trip 6
realocation move 1 is executed on taxi trip 7
realocation move 5 is executed on taxi trip 7
realocation move 14 is executed on taxi trip 7
realocation move 34 is executed on taxi trip 7
realocation move 39 is executed on taxi trip 7
realocation move 45 is executed on taxi trip 7
realocation move 57 is executed on taxi trip 7
realocation move 58 is executed on taxi trip 7
realocation move 8 is executed on taxi trip 8
realocation move 15 is executed on taxi trip 8
realocation move 21 is executed on taxi trip 8
realocation move 23 is executed on taxi trip 8
realocation move 26 is executed on taxi trip 8
realocation move 32 is executed on taxi trip 8
realocation move 33 is executed on taxi trip 8
realocation move 56 is executed on taxi trip 8
```

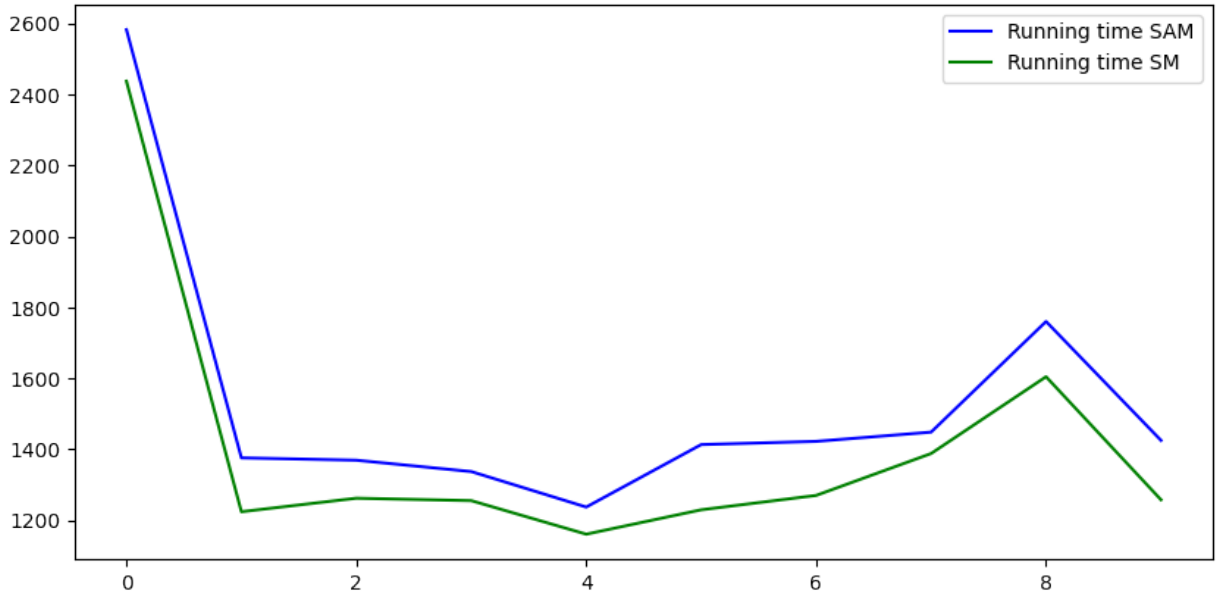
```
Binary variables: 1, if taxi trip i in I is selected from the pool; 0,oth
erwise
taxi trip 0 is selected from the pool
taxi trip 1 is selected from the pool
taxi trip 2 is selected from the pool
taxi trip 3 is selected from the pool
taxi trip 4 is selected from the pool
taxi trip 6 is selected from the pool
taxi trip 7 is selected from the pool
taxi trip 8 is selected from the pool
Set parameter TimeLimit to value 60
Gurobi Optimizer version 9.5.1 build v9.5.1rc2 (mac64[x86])
Thread count: 4 physical cores, 8 logical processors, using up to 8 threa
ds
Optimize a model with 60 rows, 9 columns and 169 nonzeros
Model fingerprint: 0x26b5efc5
Variable types: 0 continuous, 9 integer (9 binary)
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [9e+01, 1e+02]
  Bounds range     [1e+00, 1e+00]
  RHS range        [1e+00, 1e+00]
Found heuristic solution: objective 699.2882402
Presolve removed 60 rows and 9 columns
Presolve time: 0.00s
Presolve: All rows and columns removed

Explored 0 nodes (0 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 1 (of 8 available processors)

Solution count 1: 699.288

Optimal solution found (tolerance 1.00e-04)
Best objective 6.992882401716e+02, best bound 6.992882401716e+02, gap 0.0
000%
```

Result first simulation

In [ ]:
```
with open('result_simulation_0.pkl','rb') as f:  # Python 3: open(..., 'r
    result_simulation=pickle.load(f)
```

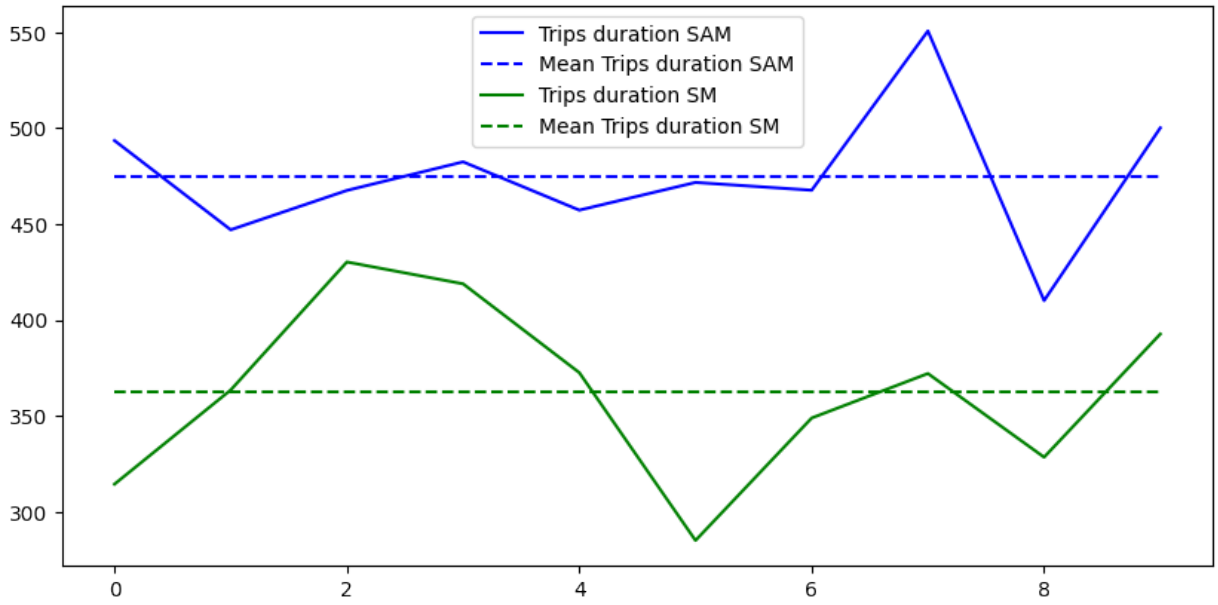
In [23]:
```
execution_times_problem=list(map(lambda x: x[3], result_simulation))
execution_times_sa=list(map(lambda x: x[5], result_simulation))
execution_times_sam=list(map(lambda x: x[7], result_simulation))
execution_times_sam_ls=list(map(lambda x: x[9], result_simulation))
execution_times_sm=list(map(lambda x: x[11], result_simulation))
execution_sm_ls=list(map(lambda x: x[13], result_simulation))

total_execution_times_sam= [x+y+z for x, y,z in zip(execution_times_sa,ex
total_execution_times_sm=[x+y+z for x, y,z in zip(execution_times_sa,exec
```

In [24]:
```
x = range(len(execution_times_problem))
fig, ax = plt.subplots(figsize=(10, 5), dpi=100)
#ax.plot(x, execution_times_problem, 'r', x, total_execution_times_sam, '
ax.plot( x, total_execution_times_sam, 'b', x, total_execution_times_sm,
#ax.legend(['Running time TRPTR-MIP', 'Running time SAM',"Running time SM
ax.legend(['Running time SAM',"Running time SM"])
plt.show()
```



In [25]:
```
result_trips_problem=list(map(lambda x: x[2], result_simulation))
result_trips_times_sam_ls=list(map(lambda x: x[8], result_simulation))
result_trips_sm_ls=list(map(lambda x: x[12], result_simulation))

result_trips_duration_problem=[ Trips.get_total_duration(trips) for trips
result_trips_duration_sam_ls=[ Trips.get_total_duration(trips) for trips
result_trips_duration_sm_ls=[ Trips.get_total_duration(trips) for trips i
```

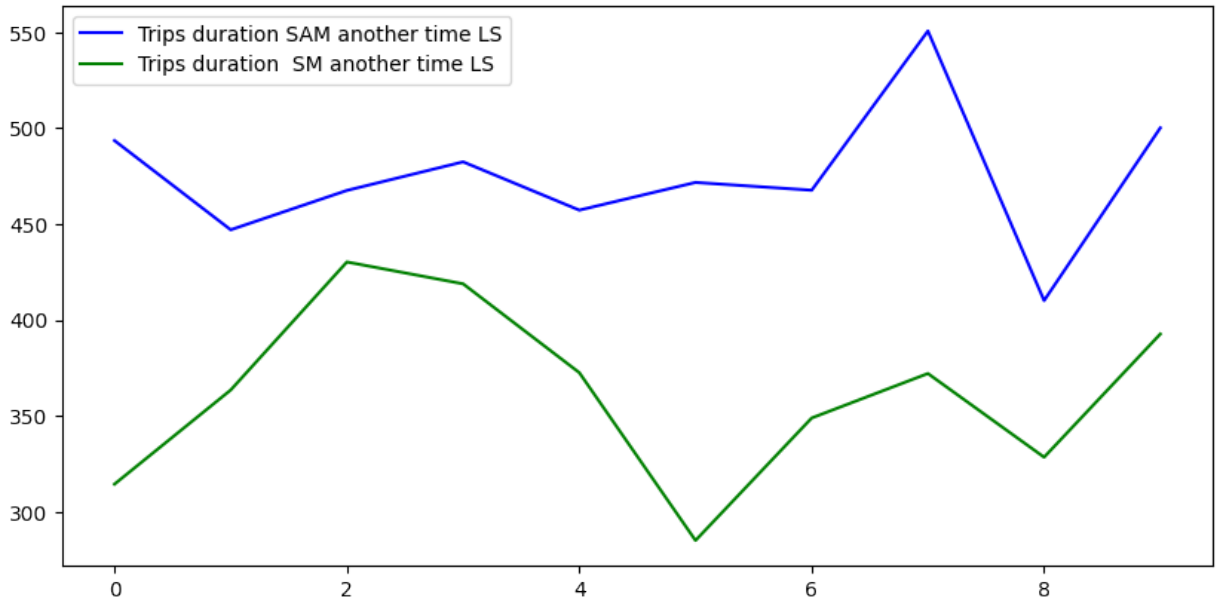
In [26]:
```
x = range(len(execution_times_problem))
fig, ax = plt.subplots(figsize=(10, 5), dpi=100)

mean_sam_ls=np.mean(result_trips_duration_sam_ls)
mean_sm_ls=np.mean(result_trips_duration_sm_ls)

mean_sam_ls_array=[mean_sam_ls for i in range(len(result_trips_duration_s
mean_sm_ls_array=[mean_sm_ls for i in range(len(result_trips_duration_sam
#ax.plot(x, result_trips_duration_problem, 'r', x, result_trips_duration_
ax.plot( x, result_trips_duration_sam_ls, 'b',x,mean_sam_ls_array,'b--',
#ax.legend(['Trips duration TRPTR-MIP', 'Trips duration SAM',"Trips durat
ax.legend([ 'Trips duration SAM',"Mean Trips duration SAM","Trips duratio
plt.show()
```



In [29]:
```
trips_sam_ls_ls=[]
running_time_sam_ls_ls=[]
trips_sm_ls_ls=[]
running_time_sm_ls_ls=[]
for result in result_simulation:
    (J,D,
       trips_problem,execution_time_problem,
       trips,execution_sa,
       trips_sam,execution_sam,
       trips_sam_ls,execution_sam_ls,
       trips_sm,execution_sm,
       trips_sm_ls,execution_sm_ls
       )=result
    start_time = time.time()
    trips_sam_ls_ls.append(Solver.local_search(n,m,J,D,kn,trips_sam_ls))
    running_time_sam_ls_ls.append(time.time()-start_time)
    start_time = time.time()
    trips_sm_ls_ls.append(Solver.local_search(n,m,J,D,kn,trips_sm_ls))
    running_time_sm_ls_ls.append(time.time()-start_time)
```

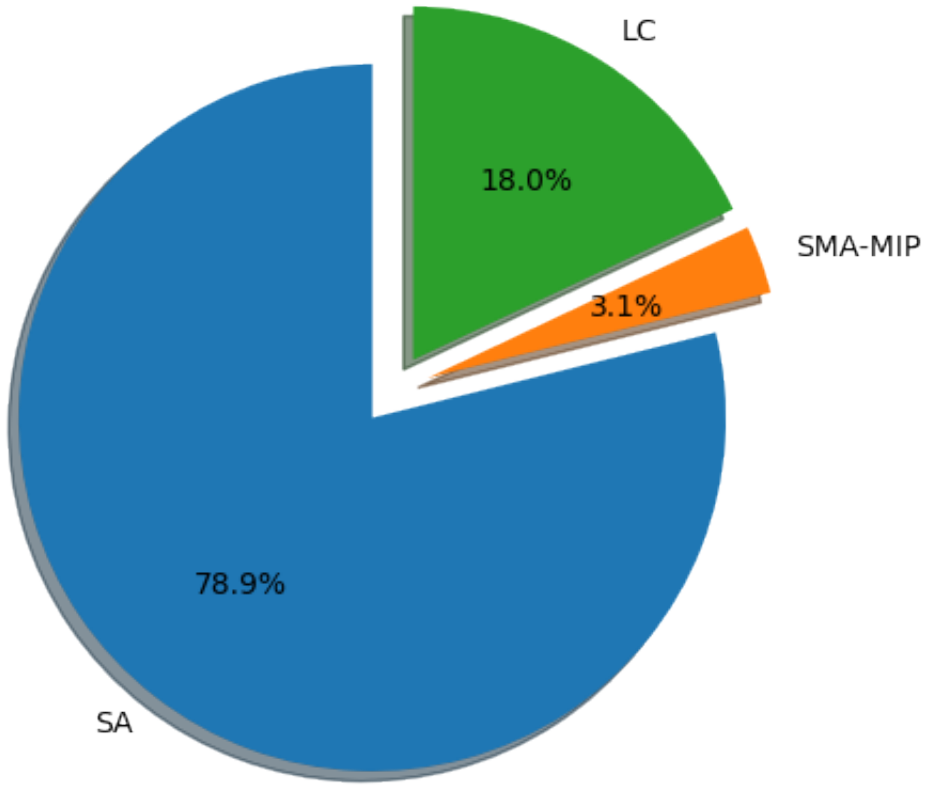
In [30]:
```
result_trips_duration_sam_ls_ls=[ Trips.get_total_duration(trips) for tri
result_trips_duration_sm_ls_ls=[ Trips.get_total_duration(trips) for trip
```

In [31]:
```
x = range(len(execution_times_problem))
fig, ax = plt.subplots(figsize=(10, 5), dpi=100)
#ax.plot(x, result_trips_duration_problem, 'r', x, result_trips_duration_
ax.plot( x, result_trips_duration_sam_ls_ls, 'b', x, result_trips_duratio
#ax.legend(['Trips duration TRPTR-MIP', 'Trips duration SAM another time
ax.legend(['Trips duration SAM another time LS',"Trips duration  SM anoth
plt.show()
```

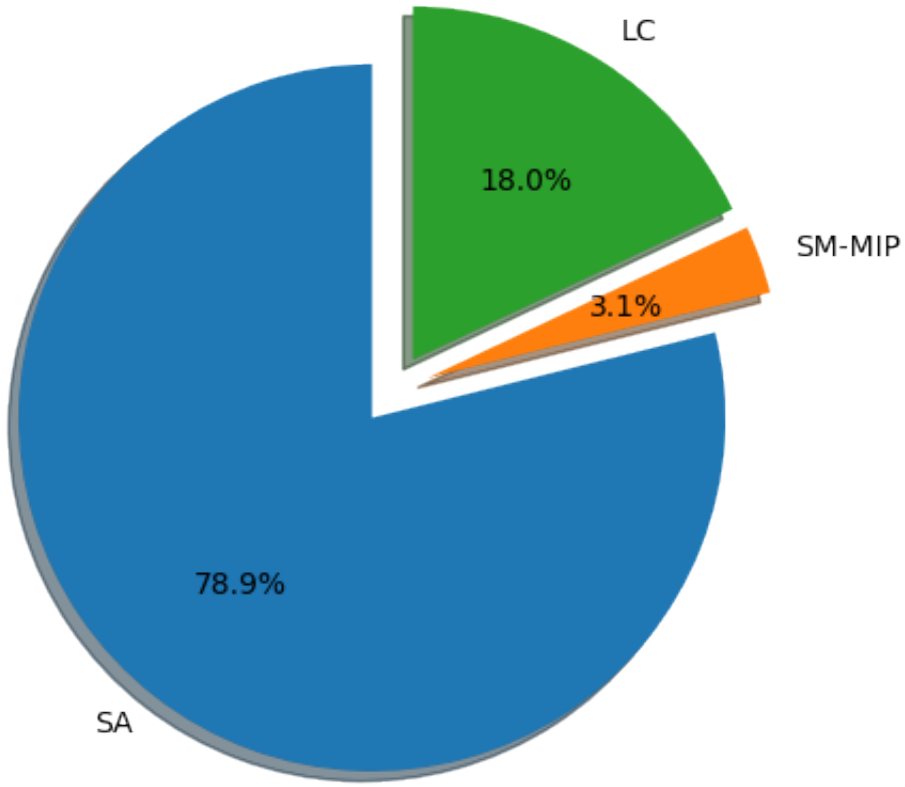


Pie Charts

In [27]:
```
execution_sa_mean=np.mean(execution_times_sa)
total_time_sam_mean=np.mean(total_execution_times_sam)
execution_sam_mean=np.mean(execution_times_sam)
execution_sam_ls_mean=np.mean(execution_times_sam_ls)

labels = 'SA', 'SMA-MIP', 'LC'
sizes = [execution_sa_mean/total_time_sam_mean*100, execution_sam_mean/to
explode = (0.1, 0.1, 0.1)

fig1, ax1 = plt.subplots(figsize=(5, 5), dpi=100)
ax1.pie(sizes, explode=explode, labels=labels, autopct='%1.1f%%',
        shadow=True, startangle=90)
ax1.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a ci

plt.show()
```



In [28]:
```
execution_sa_mean=np.mean(execution_times_sa)
total_time_sm_mean=np.mean(total_execution_times_sam)
execution_sm_mean=np.mean(execution_times_sam)
execution_sm_ls_mean=np.mean(execution_times_sam_ls)

labels = 'SA', 'SM-MIP', 'LC'
sizes = [execution_sa_mean/total_time_sm_mean*100, execution_sm_mean/tota
explode = (0.1, 0.1, 0.1)

fig1, ax1 = plt.subplots(figsize=(5, 5), dpi=100)
ax1.pie(sizes, explode=explode, labels=labels, autopct='%1.1f%%',
        shadow=True, startangle=90)
ax1.axis('equal')  # Equal aspect ratio ensures that pie is drawn as a ci

plt.show()
```

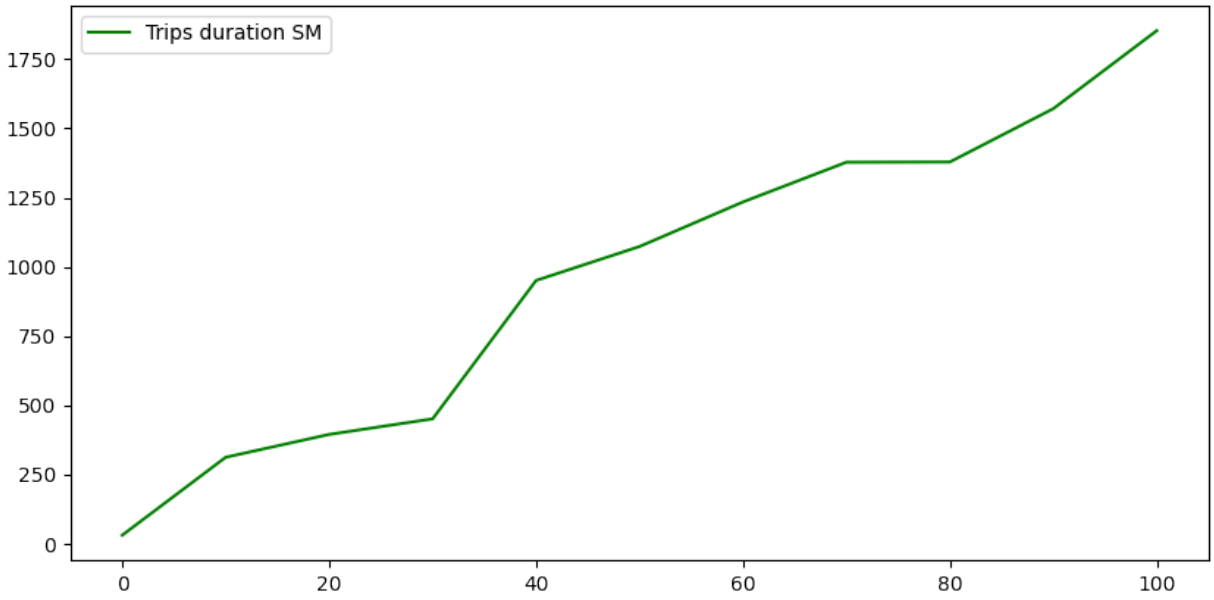


Scalability SM

In [ ]:
```
times=[]
goals_obtained=[]
for n in range(0,102,10):
    if n==0:
        n=1
    if n<=5:
        _,m,ks,kr,kn,T_start,c=Simulation.get_simulation_number(0)
    elif n>5 and n<=30:
        _,m,ks,kr,kn,T_start,c=Simulation.get_simulation_number(1)
    else:
        _,m,ks,kr,kn,T_start,c=Simulation.get_simulation_number(2)
    J,D=Simulation.initialize_map(n)

    start_time = time.time()
    trips=Solver.sa_approach(n, m, ks, kr, kn, T_start, c, J, D, Point(0,
    execution_sa=time.time()-start_time

    start_time = time.time()
    trips_sm=Solver.sm_matheuristic(J,D,trips)
    execution_sm=time.time()-start_time

    start_time = time.time()
    trips_sm_ls=Solver.local_search(n,m,J, D, 100000,trips_sm)
    execution_sm_ls=time.time()-start_time

    times.append([execution_sa,execution_sm,execution_sm_ls])
    goals_obtained.append(Trips.get_total_duration(trips_sm_ls))
```

In [13]:
```
total_time=[ np.sum(time) for time in times ]
```

In [10]:
```
t = range(len(times))
fig, ax = plt.subplots(figsize=(10, 5), dpi=100)
#ax.plot(x, result_trips_duration_problem, 'r', x, result_trips_duration_
ax.plot(range(0,102,10), total_time, 'g')
#ax.legend(['Trips duration TRPTR-MIP', 'Trips duration SAM another time
ax.legend(['Trips duration SM'])
plt.show()
```



In [6]:
```
with open(f'scalability_sm_simulation_4.pkl', 'wb') as f:  # Python 3: op
        pickle.dump((times,goals_obtained), f)
```

In [8]:
```
with open('scalability_sm_simulation.pkl','rb') as f:  # Python 3: open(.
    (times,goals_obtained)=pickle.load(f)
```

In [ ]: