Python Code for Site-Dependent Multi-Trip Periodic Vehicle Routing Problem

April 23, 2023

[76]:
```
import math
import itertools
from pulp import *
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sn
```

[4]:
```
print("Site-Dependent Multi-Trip Periodic Vehicle Routing Problem")
print("We have 10 input files")
files=["sdmtpvrp1.txt","sdmtpvrp2.txt","sdmtpvrp3.txt","sdmtpvrp4.
 ↪txt","sdmtpvrp5.txt","sdmtpvrp6.txt","sdmtpvrp7.txt","sdmtpvrp8.
 ↪txt","sdmtpvrp9.txt","sdmtpvrp10.txt"]
print("Choosing the first file to work upon")
file=0 #change the value of this file variable(0-9) to change the file of your␣
 ↪choice
```

```
Site-Dependent Multi-Trip Periodic Vehicle Routing Problem
We have 10 input files
Choosing the first file to work upon
```

[6]:
```
with open(files[0], 'r') as f:

    # read the first line of the file
    n, t, C, P, m, tt = map(float, f.readline().split())

    # read the depot information
    depot_x, depot_y, lt = map(float, f.readline().split())

    # create a list to store the vehicle information
    vehicles = []

    # read the information for each vehicle
    for i in range(int(m)):
        p, Q, D, c = map(int, f.readline().split())
        vehicles.append((p, Q, D, c))
```

```
    # create a list to store the customer information
    customers = []

    # read the information for each customer
    for i in range(int(n)):
        line =f.readline()
        line = line.strip().split()
        line_len=len(line)
        rem_len=line_len-6
        x = float(line[0])
        y = float(line[1])
        q = int(line[2])
        ut = int(line[3])
        freq = int(line[4])
        a = int(line[5])
        list1 = list(map(int, line[6:6+a]))
        e = int(line[7+a])
        list2 = list(map(int, line[7+a:]))
        customers.append((x, y, q, ut, freq, a, list1, e, list2))

    # create a list to store the delivery-day pattern information
    delivery_patterns = []

    #read the information for each delivery-day pattern
    for i in range(int(C)):
        line =f.readline()
        line = line.strip().split()
        freq = int(line[0])
        days = list(map(int, line[1:]))
        delivery_patterns.append((freq, days))
```

[7]:
```
#function to print input data
def print_input():
    print("The input parameters are as follows:\n")
    print("GENERAL INFORMATION:\n")
    print("\tNumber of customers: ",int(n))
    print("\tNumber of days of the period: ",int(t))
    print("\tTotal number of delivery-day patterns: ",int(C))
    print("\tTotal number of vehicle types: ",int(P))
    print("\tNumber of vehicles: ",int(m))
    print("\tProportionality constant for travel time: ",int(tt))
    print()
    print("DEPOT INFORMATION\n")
    print("\tDepot Location on x-y axis: ",int(depot_x)," , ",int(depot_y))
    print("\tProportionality constant for load time: ",int(lt))
    print()
```

```
    print("VEHICLE INFORMATION\n")
    for i in range(int(m)):
        print("\tVehicle ",i+1,":")
        print("\t\tVehicle Type: ",int(vehicles[i][0]))
        print("\t\tMaximum Load: ",int(vehicles[i][1]))
        print("\t\tMaximum duration of a route: ",int(vehicles[i][2]))
        print("\t\tOperation cost per unit of distance travelled:␣
↪",int(vehicles[i][3]))
        print()
    print("CUSTOMER INFORMATION\n")
    for i in range(int(n)):
        print("\tCustomer ",i+1,":")
        print("\t\tCustomer Location: ",int(customers[i][0])," ,␣
↪",int(customers[i][1]))
        print("\t\tDemand: ",int(customers[i][2]))
        print("\t\tProportionality constant for unload time:␣
↪",int(customers[i][3]))
        print("\t\tFrequency of a visit: ",int(customers[i][4]))
        print("\t\tNumber of possible visit combinations: ",int(customers[i][5]))
        print("\t\tList of all possible visit combinations: ",' , '.
↪join(map(str,customers[i][6])))
        print("\t\tNumber of possible vehicle types: ",int(customers[i][7]))
        print("\t\tList of all possible vehicle types: ",' , '.
↪join(map(str,customers[i][8])))
        print()
    print("EACH DEILVERY DAY PATTERN INFORMATION\n")
    for i in range(int(C)):
        print("\tPattern ",i+1,":")
        print("\t\tFrequency of visit: ",int(delivery_patterns[i][0]))
        print("\t\tList visit days: ",' , '.
↪join(map(str,delivery_patterns[i][1])))
        print()
```

[79]:
```
# Define distance function
def distance(a, b):
    return math.sqrt((a[0]-b[0])**2 + (a[1]-b[1])**2) * tt

# Define load time function
def load_time(q):
    return q * depot_y

# Define unload time function
def unload_time(q):
    return q * ut

# Define cost function
def cost(distance, vehicle_type):
```

```
    return distance * vehicles[vehicle_type][3]

# Define state representation
# A state is represented as a tuple (remaining_customers, current_load,␣
 ↪current_location, current_time, current_vehicle_type)
# where remaining_customers is a list of customer indices, current_load is the␣
 ↪current load on the vehicle,
# current_location is a tuple (x, y) representing the current location of the␣
 ↪vehicle,
# current_time is the current time, and current_vehicle_type is the index of the␣
 ↪current vehicle type in the vehicles list.
# The state also includes the cost incurred so far.
def state(remaining_customers, current_load, current_location, current_time,␣
 ↪current_vehicle_type, cost_so_far):
    return (remaining_customers, current_load, current_location, current_time,␣
 ↪current_vehicle_type, cost_so_far)

# Define initial state
initial_state = state(list(range(int(n))), 0, (depot_x, depot_y), 0, 0, 0)


# Define goal test function
def is_goal(state):
    return not state[0] and state[1] == 0
```

[8]:
```
print_input()
```

```
The input parameters are as follows:

GENERAL INFORMATION:

        Number of customers:  50
        Number of days of the period:  2
        Total number of delivery-day patterns:  3
        Total number of vehicle types:  2
        Number of vehicles:  2
        Proportionality constant for travel time:  1

DEPOT INFORMATION

        Depot Location on x-y axis:  19  ,  -15
        Proportionality constant for load time:  2

VEHICLE INFORMATION

        Vehicle  1 :
                Vehicle Type:  1
```

```
        Maximum Load:  100
        Maximum duration of a route:  1800
        Operation cost per unit of distance travelled:  1

    Vehicle  2 :
        Vehicle Type:  2
        Maximum Load:  150
        Maximum duration of a route:  1800
        Operation cost per unit of distance travelled:  2

CUSTOMER INFORMATION

    Customer  1 :
        Customer Location:  -22  ,  -16
        Demand:  3
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

    Customer  2 :
        Customer Location:  21  ,  42
        Demand:  21
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

    Customer  3 :
        Customer Location:  25  ,  23
        Demand:  18
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

    Customer  4 :
        Customer Location:  -38  ,  -51
        Demand:  4
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
```

```
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  5 :
        Customer Location:  7  ,  -39
        Demand:  1
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  6 :
        Customer Location:  41  ,  -90
        Demand:  5
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  7 :
        Customer Location:  -22  ,  -25
        Demand:  13
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  8 :
        Customer Location:  34  ,  -84
        Demand:  20
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  9 :
        Customer Location:  -25  ,  -46
        Demand:  9
        Proportionality constant for unload time:  2
```

```
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  10 :
        Customer Location:  88  ,  5
        Demand:  2
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  11 :
        Customer Location:  -31  ,  60
        Demand:  15
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  12 :
        Customer Location:  70  ,  -77
        Demand:  12
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  13 :
        Customer Location:  76  ,  -10
        Demand:  21
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  14 :
        Customer Location:  -33  ,  2
```

```
        Demand:  1
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  15 :
        Customer Location:  -4  ,  -35
        Demand:  4
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  16 :
        Customer Location:  -14  ,  3
        Demand:  16
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  17 :
        Customer Location:  19  ,  11
        Demand:  14
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  18 :
        Customer Location:  -48  ,  -93
        Demand:  13
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2
```

```
Customer  19 :
        Customer Location:  -4  ,  -49
        Demand:  12
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  20 :
        Customer Location:  10  ,  -63
        Demand:  7
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  21 :
        Customer Location:  1  ,  -27
        Demand:  25
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  22 :
        Customer Location:  -36  ,  -12
        Demand:  16
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  23 :
        Customer Location:  60  ,  68
        Demand:  22
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
```

```
        List of all possible vehicle types:  2

Customer  24 :
        Customer Location:  54  ,  -9
        Demand:  12
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  2
        List of all possible vehicle types:  2

Customer  25 :
        Customer Location:  -71  ,  -14
        Demand:  17
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  26 :
        Customer Location:  37  ,  4
        Demand:  21
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  27 :
        Customer Location:  -12  ,  44
        Demand:  11
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  28 :
        Customer Location:  5  ,  22
        Demand:  12
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
```

```
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  29 :
        Customer Location:  -40  ,  25
        Demand:  10
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  30 :
        Customer Location:  12  ,  -54
        Demand:  14
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  31 :
        Customer Location:  8  ,  -62
        Demand:  7
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  32 :
        Customer Location:  -30  ,  56
        Demand:  14
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  33 :
        Customer Location:  -5  ,  16
        Demand:  22
        Proportionality constant for unload time:  2
```

```
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  34 :
        Customer Location:  6  ,  41
        Demand:  19
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  35 :
        Customer Location:  -4  ,  55
        Demand:  4
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  36 :
        Customer Location:  31  ,  4
        Demand:  7
        Proportionality constant for unload time:  2
        Frequency of a visit:  1
        Number of possible visit combinations:  2
        List of all possible visit combinations:  1 , 2
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  37 :
        Customer Location:  6  ,  50
        Demand:  21
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  38 :
        Customer Location:  8  ,  17
```

```
        Demand:  24
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  39 :
        Customer Location:  -25  ,  -18
        Demand:  23
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  40 :
        Customer Location:  37  ,  34
        Demand:  8
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  41 :
        Customer Location:  53  ,  13
        Demand:  12
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  42 :
        Customer Location:  44  ,  30
        Demand:  22
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1
```

```
Customer  43 :
        Customer Location:  -50  ,  -39
        Demand:  21
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1

Customer  44 :
        Customer Location:  -19  ,  -28
        Demand:  25
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  45 :
        Customer Location:  15  ,  -39
        Demand:  5
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  46 :
        Customer Location:  -64  ,  6
        Demand:  3
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
        List of all possible vehicle types:  1 , 2

Customer  47 :
        Customer Location:  4  ,  38
        Demand:  24
        Proportionality constant for unload time:  2
        Frequency of a visit:  2
        Number of possible visit combinations:  1
        List of all possible visit combinations:  3
        Number of possible vehicle types:  1
```

```
            List of all possible vehicle types:  1 , 2

        Customer  48 :
            Customer Location:  33  ,  20
            Demand:  14
            Proportionality constant for unload time:  2
            Frequency of a visit:  2
            Number of possible visit combinations:  1
            List of all possible visit combinations:  3
            Number of possible vehicle types:  1
            List of all possible vehicle types:  1 , 2

        Customer  49 :
            Customer Location:  73  ,  30
            Demand:  6
            Proportionality constant for unload time:  2
            Frequency of a visit:  2
            Number of possible visit combinations:  1
            List of all possible visit combinations:  3
            Number of possible vehicle types:  1
            List of all possible vehicle types:  1 , 2

        Customer  50 :
            Customer Location:  -22  ,  -20
            Demand:  20
            Proportionality constant for unload time:  2
            Frequency of a visit:  2
            Number of possible visit combinations:  1
            List of all possible visit combinations:  3
            Number of possible vehicle types:  1
            List of all possible vehicle types:  1 , 2

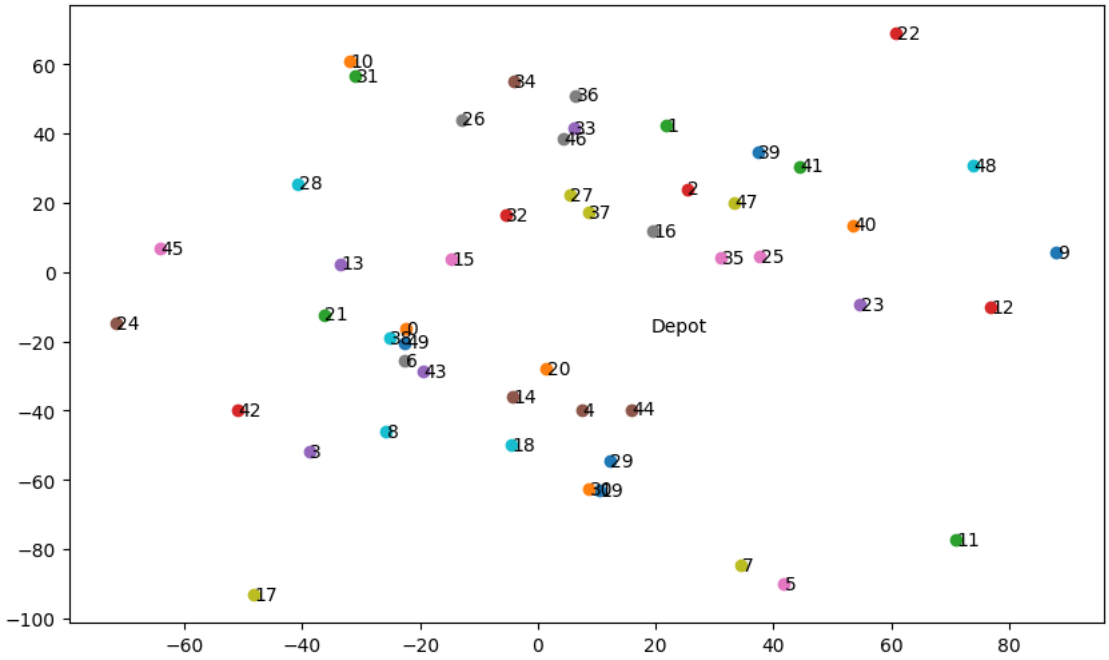
EACH DEILVERY DAY PATTERN INFORMATION

        Pattern  1 :
            Frequency of visit:  1
            List visit days:  1

        Pattern  2 :
            Frequency of visit:  1
            List visit days:  2

        Pattern  3 :
            Frequency of visit:  2
            List visit days:  1 , 2
```

[86]:
```
plt.figure(figsize=(10,6))
plt.plot(depot_x,depot_y)
plt.text(depot_x+.
 ↪01,depot_y,"Depot",horizontalalignment='left',verticalalignment='center')
for s in range(len(customers)):
    p = customers[s]
    plt.plot(p[0],p[1],'o')
    plt.text(float(p[0])+0.
 ↪1,p[1],s,horizontalalignment='left',verticalalignment='center')
```



[87]:
```
position=pd.DataFrame(columns=["Customer","X","Y"])
for i in range(len(customers)):
    new_row = {'Customer':i, 'X':int(customers[i][0]), 'Y':int(customers[i][1])}
    position = pd.concat([position, pd.DataFrame([new_row])], ignore_index=True)
```

[88]:
```
position.head()
```

[88]:

	Customer	X	Y
0	0	-22	-16
1	1	21	42
2	2	25	23
3	3	-38	-51
4	4	7	-39

[89]:
```
x_coords = position['X'].values.astype(float)
y_coords = position['Y'].values.astype(float)

# Compute the distance matrix using the Euclidean distance formula
distance_matrix = np.sqrt((x_coords[:, np.newaxis] - x_coords)**2 + (y_coords[:,␣
↪np.newaxis] - y_coords)**2)
```

[90]:
```
distance_matrix_df = pd.DataFrame(distance_matrix)
```

[149]:
```
travelTIme=df_new = distance_matrix_df.multiply(tt)
```

[154]:
```
travelTIme.head()
```

[154]:

	0	1	2	3	4	5	\
0	0.000000	86.641330	73.288471	46.180515	44.416213	116.622468	
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[5 rows x 50 columns]

[91]:
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↪range(len(position)) for s2 in range(len(position)) if s1!=s2)
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(19, 39): 100.68763578513501,
(19, 40): 87.32124598286491,
(19, 41): 99.02019995940222,
(19, 42): 64.62197768561404,
(19, 43): 45.45327270945405,
(19, 44): 24.515301344262525,
(19, 45): 101.17806086301516,
(19, 46): 101.17806086301516,
(19, 47): 86.1278120005379,
(19, 48): 112.32987136109433,
(19, 49): 53.600373133029585,
(20, 0): 25.495097567963924,
(20, 1): 71.84010022264724,
(20, 2): 55.46169849544819,
(20, 3): 45.79301256742124,
(20, 4): 13.416407864998739,
(20, 5): 74.62573282722254,
(20, 6): 23.08679276123039,
```

```
 (20, 7): 65.86349520030045,
 (20, 8): 32.202484376209235,
 (20, 9): 92.69843580125827,
 (20, 10): 92.69843580125827,
 (20, 11): 85.21150157109074,
 (20, 12): 76.90253571892151,
 (20, 13): 44.68780594300866,
 (20, 14): 9.433981132056603,
 (20, 15): 33.54101966249684,
 (20, 16): 42.04759208325728,
 (20, 17): 82.20097323024831,
 (20, 18): 22.561028345356956,
 (20, 19): 37.107950630558946,
 ...}
```

[112]:
```
sites=[]
for i in range(len(customers)):
    sites.append((i))
```

[104]:
```
K=1
```

[113]:
```
x = LpVariable.dicts('x',distances, 0,1,LpBinary)
#dummy vars to eliminate subtours
u = LpVariable.dicts('u', sites, 0, len(sites)-1, LpInteger)
```

[114]:
```
prob=LpProblem("vehicle", LpMinimize)
```

[115]:
```
#indicator variable if site i is connected to site j in the tour
x = LpVariable.dicts('x',distances, 0,1,LpBinary)
#dummy vars to eliminate subtours
u = LpVariable.dicts('u', sites, 0, len(sites)-1, LpInteger)
```

[116]:
```
positions = dict( ( city, (position.loc[city, 'X'], position.loc[city, 'Y']) )␣
 ↪for city in sites)
```

[117]:
```
#the objective
cost = lpSum([x[(i,j)]*distances[(i,j)] for (i,j) in distances])
prob+=cost
```

[118]:
```
prob
```

[118]:
```
vehicle:
MINIMIZE
72.20110802473879*x_(0,_1) + 76.53103945458993*x_(0,_10) +
110.38568747804219*x_(0,_11) + 98.18350166906862*x_(0,_12) +
21.095023109728988*x_(0,_13) + 26.1725046566048*x_(0,_14) +
20.615528128088304*x_(0,_15) + 49.09175083453431*x_(0,_16) +
```

```
81.27115109311545*x_(0,_17) + 37.589892258425*x_(0,_18) +
56.859475903318*x_(0,_19) + 61.07372593840988*x_(0,_2) +
25.495097567963924*x_(0,_20) + 14.560219778561036*x_(0,_21) +
117.38824472663352*x_(0,_22) + 76.32168761236873*x_(0,_23) +
49.040799340956916*x_(0,_24) + 62.297672508690084*x_(0,_25) +
60.8276253029822*x_(0,_26) + 46.61544808322666*x_(0,_27) +
44.77722635447622*x_(0,_28) + 50.99019513592785*x_(0,_29) +
38.48376280978771*x_(0,_3) + 54.91812087098393*x_(0,_30) +
72.44308110509934*x_(0,_31) + 36.235341863986875*x_(0,_32) +
63.50590523722971*x_(0,_33) + 73.24616030891995*x_(0,_34) +
56.64803615307419*x_(0,_35) + 71.69379331573968*x_(0,_36) +
44.598206241955516*x_(0,_37) + 3.605551275463989*x_(0,_38) +
77.33692520394123*x_(0,_39) + 37.013511046643494*x_(0,_4) +
80.4114419718985*x_(0,_40) + 80.44874144447506*x_(0,_41) +
36.235341863986875*x_(0,_42) + 12.36931687685298*x_(0,_43) +
43.56604182158393*x_(0,_44) + 47.41307836451879*x_(0,_45) +
59.93329625508679*x_(0,_46) + 65.73431371817918*x_(0,_47) +
105.55093557141026*x_(0,_48) + 4.0*x_(0,_49) + 97.18538984847466*x_(0,_5) +
9.0*x_(0,_6) + 88.09086218218096*x_(0,_7) + 30.14962686336267*x_(0,_8) +
111.9866063420086*x_(0,_9) + 72.20110802473879*x_(1,_0) +
55.02726596879042*x_(1,_10) + 128.69343417595164*x_(1,_11) +
75.69015788066504*x_(1,_12) + 67.20119046564577*x_(1,_13) +
80.95677859203639*x_(1,_14) + 52.40229002629561*x_(1,_15) +
31.064449134018133*x_(1,_16) + 151.61134522191932*x_(1,_17) +
94.37160589923221*x_(1,_18) + 105.57461816175325*x_(1,_19) +
19.4164878389476*x_(1,_2) + 71.84010022264724*x_(1,_20) +
78.5175139698144*x_(1,_21) + 46.87216658103186*x_(1,_22) +
60.74537019394976*x_(1,_23) + 107.70329614269008*x_(1,_24) +
41.23105625617661*x_(1,_25) + 33.06055050963308*x_(1,_26) +
25.612496949731394*x_(1,_27) + 63.324560795950255*x_(1,_28) +
96.42095207992918*x_(1,_29) + 110.13627921806692*x_(1,_3) +
104.80935072788114*x_(1,_30) + 52.88667128870941*x_(1,_31) +
36.76955262170047*x_(1,_32) + 15.033296378372908*x_(1,_33) +
28.178005607210743*x_(1,_34) + 39.293765408777*x_(1,_35) + 17.0*x_(1,_36) +
28.178005607210743*x_(1,_37) + 75.6042326857432*x_(1,_38) +
17.88854381999832*x_(1,_39) + 82.20097323024831*x_(1,_4) +
43.18564576337837*x_(1,_40) + 25.942243542145693*x_(1,_41) +
107.71258050942797*x_(1,_42) + 80.62257748298549*x_(1,_43) +
81.2219182240853*x_(1,_44) + 92.30926280715278*x_(1,_45) +
17.46424919657298*x_(1,_46) + 25.059928172283335*x_(1,_47) +
53.36665625650534*x_(1,_48) + 75.45197147855052*x_(1,_49) +
133.5065541462291*x_(1,_5) + 79.61155694998057*x_(1,_6) +
126.66885963013956*x_(1,_7) + 99.29753269845128*x_(1,_8) +
76.53757247260981*x_(1,_9) + 76.53103945458993*x_(10,_0) +
55.02726596879042*x_(10,_1) + 170.20575783445165*x_(10,_11) +
127.8632081562167*x_(10,_12) + 58.034472514187634*x_(10,_13) +
98.76234100101111*x_(10,_14) + 59.481089431852205*x_(10,_15) +
```

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70.00714249274856*x_(10,_16) + 153.9415473483361*x_(10,_17) +
112.29425630903836*x_(10,_18) + 129.65338406690356*x_(10,_19) +
67.11929677819934*x_(10,_2) + 92.69843580125827*x_(10,_20) +
72.17340230306452*x_(10,_21) + 91.35097153287424*x_(10,_22) +
109.48059188732951*x_(10,_23) + 84.11896337925236*x_(10,_24) +
88.09086218218096*x_(10,_25) + 24.839484696748443*x_(10,_26) +
52.3450093132096*x_(10,_27) + 36.138621999185304*x_(10,_28) +
121.8400590938793*x_(10,_29) + 111.22050170719426*x_(10,_3) +
128.08200498118384*x_(10,_30) + 4.123105625617661*x_(10,_31) +
51.10772935672255*x_(10,_32) + 41.593268686170845*x_(10,_33) +
27.459060435491963*x_(10,_34) + 83.54639429682169*x_(10,_35) +
38.3275357934736*x_(10,_36) + 58.05170109479997*x_(10,_37) +
78.23042886243178*x_(10,_38) + 72.80109889280519*x_(10,_39) +
106.04244433244644*x_(10,_4) + 96.25487000666512*x_(10,_40) +
80.77747210701756*x_(10,_41) + 100.80674580602232*x_(10,_42) +
88.81441324469807*x_(10,_43) + 109.16501271011697*x_(10,_44) +
63.28506932918696*x_(10,_45) + 41.340053217188775*x_(10,_46) +
75.47184905645283*x_(10,_47) + 108.24047302187847*x_(10,_48) +
80.50465825031493*x_(10,_49) + 166.38509548634457*x_(10,_5) +
85.47514258543241*x_(10,_6) + 157.99050604387594*x_(10,_7) +
106.16967551989597*x_(10,_8) + 131.0953851209111*x_(10,_9) +
110.38568747804219*x_(11,_0) + 128.69343417595164*x_(11,_1) +
170.20575783445165*x_(11,_10) + 67.26812023536856*x_(11,_12) +
129.80754985747168*x_(11,_13) + 85.0881895447306*x_(11,_14) + 116.0*x_(11,_15) +
101.71037311896953*x_(11,_16) + 119.07980517283357*x_(11,_17) +
79.12016177940993*x_(11,_18) + 61.61168720299745*x_(11,_19) +
109.65856099730654*x_(11,_2) + 85.21150157109074*x_(11,_20) +
124.34226956268733*x_(11,_21) + 145.34441853748632*x_(11,_22) +
69.85699678629192*x_(11,_23) + 154.434452114805*x_(11,_24) +
87.46427842267951*x_(11,_25) + 146.16771189288008*x_(11,_26) +
118.43141475132347*x_(11,_27) + 150.0133327407934*x_(11,_28) +
62.39390995922599*x_(11,_29) + 111.08555261599052*x_(11,_3) +
63.788713735268246*x_(11,_30) + 166.4001201922643*x_(11,_31) +
119.47384651043926*x_(11,_32) + 134.23859355639868*x_(11,_33) +
151.32745950421557*x_(11,_34) + 89.89994438263018*x_(11,_35) +
142.21462653327893*x_(11,_36) + 112.60550608207397*x_(11,_37) +
111.83022847155415*x_(11,_38) + 115.80155439371269*x_(11,_39) +
73.57309290766564*x_(11,_4) + 91.59148432032315*x_(11,_40) +
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101.59724405711013*x_(11,_43) + 66.85057965343307*x_(11,_44) +
157.62296786953354*x_(11,_45) + 132.59336333316233*x_(11,_46) +
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99.92997548283498*x_(11,_8) + 83.95236744726142*x_(11,_9) +
98.18350166906862*x_(12,_0) + 75.69015788066504*x_(12,_1) +
127.8632081562167*x_(12,_10) + 67.26812023536856*x_(12,_11) +
```

```
109.65856099730654*x_(12,_13) + 83.81527307120105*x_(12,_14) +
90.93404203047393*x_(12,_15) + 60.74537019394976*x_(12,_16) +
149.21461054467824*x_(12,_17) + 89.0*x_(12,_18) + 84.64632301523794*x_(12,_19) +
60.74537019394976*x_(12,_2) + 76.90253571892151*x_(12,_20) +
112.01785571952357*x_(12,_21) + 79.62411694957753*x_(12,_22) +
22.02271554554524*x_(12,_23) + 147.05441169852742*x_(12,_24) +
41.43669871020132*x_(12,_25) + 103.24727599312246*x_(12,_26) +
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85.60373823613078*x_(12,_30) + 124.86793023030373*x_(12,_31) +
85.07055894961546*x_(12,_32) + 86.6083136886985*x_(12,_33) +
103.07764064044152*x_(12,_34) + 47.12748667179272*x_(12,_35) +
92.19544457292888*x_(12,_36) + 73.16419889536138*x_(12,_37) +
101.31633629380802*x_(12,_38) + 58.7962583843564*x_(12,_39) +
74.84650960465692*x_(12,_4) + 32.526911934581186*x_(12,_40) +
51.22499389946279*x_(12,_41) + 129.29423807734048*x_(12,_42) +
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107.2240644631605*x_(12,_8) + 19.209372712298546*x_(12,_9) +
21.095023109728988*x_(13,_0) + 67.20119046564577*x_(13,_1) +
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96.17692030835673*x_(13,_17) + 58.66856057549052*x_(13,_18) +
77.93587107359485*x_(13,_19) + 61.68468205316454*x_(13,_2) +
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46.95742752749558*x_(13,_26) + 42.941821107167776*x_(13,_27) +
24.041630560342615*x_(13,_28) + 71.84010022264724*x_(13,_29) +
53.23532661682466*x_(13,_3) + 76.00657866263946*x_(13,_30) +
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43.657759905886145*x_(13,_37) + 21.540659228538015*x_(13,_38) +
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86.70063436907483*x_(13,_40) + 81.93289937503738*x_(13,_41) +
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51.62363799656123*x_(13,_46) + 68.41052550594829*x_(13,_47) +
109.63576058932597*x_(13,_48) + 24.596747752497688*x_(13,_49) +
118.06777714516353*x_(13,_5) + 29.154759474226502*x_(13,_6) +
109.01834707974616*x_(13,_7) + 48.662100242385755*x_(13,_8) +
121.03718436910205*x_(13,_9) + 26.1725046566048*x_(14,_0) +
```

```
80.95677859203639*x_(14,_1) + 98.76234100101111*x_(14,_10) +
85.0881895447306*x_(14,_11) + 83.81527307120105*x_(14,_12) +
47.01063709417264*x_(14,_13) + 39.293765408777*x_(14,_15) +
51.42956348249516*x_(14,_16) + 72.80109889280519*x_(14,_17) + 14.0*x_(14,_18) +
31.304951684997057*x_(14,_19) + 64.8459713474939*x_(14,_2) +
9.433981132056603*x_(14,_20) + 39.408120990476064*x_(14,_21) +
121.26417442921878*x_(14,_22) + 63.56099432828282*x_(14,_23) +
70.21395872616783*x_(14,_24) + 56.586217403180434*x_(14,_25) +
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69.9714227381436*x_(14,_28) + 24.839484696748443*x_(14,_29) +
37.57658845611187*x_(14,_3) + 29.546573405388315*x_(14,_30) +
94.64142856064674*x_(14,_31) + 51.0098029794274*x_(14,_32) +
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85.58621384311844*x_(14,_36) + 53.36665625650534*x_(14,_37) +
27.018512172212592*x_(14,_38) + 80.26207074328447*x_(14,_39) +
11.704699910719626*x_(14,_4) + 74.51845409024533*x_(14,_40) +
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16.55294535724685*x_(14,_43) + 19.4164878389476*x_(14,_44) +
72.67048919609665*x_(14,_45) + 73.43704787094863*x_(14,_46) +
66.2872536767062*x_(14,_47) + 100.7670581092849*x_(14,_48) +
23.430749027719962*x_(14,_49) + 71.06335201775947*x_(14,_5) +
20.591260281974*x_(14,_6) + 62.00806399170998*x_(14,_7) +
23.706539182259394*x_(14,_8) + 100.31948963187563*x_(14,_9) +
20.615528128088304*x_(15,_0) + 52.40229002629561*x_(15,_1) +
59.481089431852205*x_(15,_10) + 116.0*x_(15,_11) + 90.93404203047393*x_(15,_12)
+ 19.026297590440446*x_(15,_13) + 39.293765408777*x_(15,_14) +
33.95585369269929*x_(15,_16) + 101.84301645179212*x_(15,_17) +
52.952809179494906*x_(15,_18) + 70.22819946431775*x_(15,_19) +
43.829214001622255*x_(15,_2) + 33.54101966249684*x_(15,_20) +
26.627053911388696*x_(15,_21) + 98.49365461794989*x_(15,_22) +
69.05070600652827*x_(15,_23) + 59.481089431852205*x_(15,_24) +
51.0098029794274*x_(15,_25) + 41.048751503547585*x_(15,_26) +
26.870057685088806*x_(15,_27) + 34.058772731852805*x_(15,_28) +
62.64982043070834*x_(15,_29) + 59.09314681077663*x_(15,_3) +
68.62215385719105*x_(15,_30) + 55.362442142665635*x_(15,_31) +
15.811388300841896*x_(15,_32) + 42.941821107167776*x_(15,_33) +
52.952809179494906*x_(15,_34) + 45.0111097397076*x_(15,_35) +
51.07837115648854*x_(15,_36) + 26.076809620810597*x_(15,_37) +
23.706539182259394*x_(15,_38) + 59.682493245507096*x_(15,_39) +
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63.97655820689325*x_(15,_41) + 55.31726674375732*x_(15,_42) +
31.400636936215164*x_(15,_43) + 51.03920062069938*x_(15,_44) +
50.08991914547278*x_(15,_45) + 39.35733730830886*x_(15,_46) +
49.9799959983992*x_(15,_47) + 91.09335870413386*x_(15,_48) +
24.351591323771842*x_(15,_49) + 108.04628637764465*x_(15,_5) +
29.120439557122072*x_(15,_6) + 99.36297097007517*x_(15,_7) +
50.21951811795888*x_(15,_8) + 102.0196059588548*x_(15,_9) +
```

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49.09175083453431*x_(16,_0) + 31.064449134018133*x_(16,_1) +
70.00714249274856*x_(16,_10) + 101.71037311896953*x_(16,_11) +
60.74537019394976*x_(16,_12) + 52.773099207835045*x_(16,_13) +
51.42956348249516*x_(16,_14) + 33.95585369269929*x_(16,_15) +
123.71337841963576*x_(16,_17) + 64.25729530566937*x_(16,_18) +
74.54528824815154*x_(16,_19) + 13.416407864998739*x_(16,_2) +
42.04759208325728*x_(16,_20) + 59.61543424315552*x_(16,_21) +
70.21395872616783*x_(16,_22) + 40.311288741492746*x_(16,_23) +
93.40770846134703*x_(16,_24) + 19.313207915827967*x_(16,_25) +
45.27692569068709*x_(16,_26) + 17.804493814764857*x_(16,_27) +
60.63827174318213*x_(16,_28) + 65.37583651472461*x_(16,_29) +
84.21995013059554*x_(16,_3) + 73.824115301167*x_(16,_30) +
66.52818951391959*x_(16,_31) + 24.515301344262525*x_(16,_32) +
32.69556544854363*x_(16,_33) + 49.64876634922564*x_(16,_34) +
13.892443989449804*x_(16,_35) + 41.10960958218893*x_(16,_36) +
12.529964086141668*x_(16,_37) + 52.69724850502159*x_(16,_38) +
29.206163733020468*x_(16,_39) + 51.419840528729765*x_(16,_4) +
34.058772731852805*x_(16,_40) + 31.400636936215164*x_(16,_41) +
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+ 24.08318915758459*x_(33,_37) + 66.64833081180653*x_(33,_38) +
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+ 118.82760622010359*x_(34,_19) + 43.18564576337837*x_(34,_2) +
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+ 50.00999900019995*x_(39,_26) + 34.17601498127012*x_(39,_27) +
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+ 82.80096617793781*x_(41,_49) + 120.03749414245534*x_(41,_5) +
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95.29428104561154*x_(7,_42) + 77.10382610480494*x_(7,_43) +
48.84669896727925*x_(7,_44) + 133.05637902783917*x_(7,_45) +
125.63439019631528*x_(7,_46) + 104.00480758118829*x_(7,_47) +
120.48651376813922*x_(7,_48) + 85.0411665018772*x_(7,_49) +
9.219544457292887*x_(7,_5) + 81.34494452638098*x_(7,_6) +
70.178344238091*x_(7,_8) + 104.10091258005379*x_(7,_9) +
30.14962686336267*x_(8,_0) + 99.29753269845128*x_(8,_1) +
106.16967551989597*x_(8,_10) + 99.92997548283498*x_(8,_11) +
107.2240644631605*x_(8,_12) + 48.662100242385755*x_(8,_13) +
23.706539182259394*x_(8,_14) + 50.21951811795888*x_(8,_15) +
72.00694410957877*x_(8,_16) + 52.32590180780452*x_(8,_17) +
21.213203435596427*x_(8,_18) + 38.91015291668744*x_(8,_19) +
85.21150157109074*x_(8,_2) + 32.202484376209235*x_(8,_20) +
35.73513677041127*x_(8,_21) + 142.20056258679148*x_(8,_22) +
87.23531395025755*x_(8,_23) + 56.0357029044876*x_(8,_24) +
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74.32361670424818*x_(8,_27) + 72.56721022610694*x_(8,_28) +
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97.8008179924892*x_(8,_40) + 102.6498904042279*x_(8,_41) +
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40.607881008493905*x_(8,_44) + 65.0*x_(8,_45) + 88.86506625215557*x_(8,_46) +
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26.1725046566048*x_(8,_49) + 79.32212806020776*x_(8,_5) +
21.213203435596427*x_(8,_6) + 70.178344238091*x_(8,_7) +
123.97580409095961*x_(8,_9) + 111.9866063420086*x_(9,_0) +
76.53757247260981*x_(9,_1) + 131.0953851209111*x_(9,_10) +
83.95236744726142*x_(9,_11) + 19.209372712298546*x_(9,_12) +
121.03718436910205*x_(9,_13) + 100.31948963187563*x_(9,_14) +
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102.0196059588548*x_(9,_15) + 69.26037828369117*x_(9,_16) +
167.6305461424021*x_(9,_17) + 106.6770828247567*x_(9,_18) +
103.47946656221224*x_(9,_19) + 65.52098900352466*x_(9,_2) +
92.69843580125827*x_(9,_20) + 125.15989773086265*x_(9,_21) +
68.94200461257273*x_(9,_22) + 36.76955262170047*x_(9,_23) +
160.13119621110684*x_(9,_24) + 51.0098029794274*x_(9,_25) +
107.33592129385204*x_(9,_26) + 84.72307831990054*x_(9,_27) +
129.55307792561317*x_(9,_28) + 96.21330469326995*x_(9,_29) +
137.88400922514546*x_(9,_3) + 104.35037134576953*x_(9,_30) +
128.5496013218244*x_(9,_31) + 93.64827814754524*x_(9,_32) +
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57.0087712549569*x_(9,_35) + 93.53608929178085*x_(9,_36) +
80.89499366462674*x_(9,_37) + 115.31695452100702*x_(9,_38) +
58.66856057549052*x_(9,_39) + 92.17917335276988*x_(9,_4) +
35.90264614203248*x_(9,_40) + 50.60632371551998*x_(9,_41) +
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90.24965373894794*x_(9,_46) + 57.0087712549569*x_(9,_47) +
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104.10091258005379*x_(9,_7) + 123.97580409095961*x_(9,_8) + 0.0
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0 <= x_(17,_42) <= 1 Integer
0 <= x_(17,_43) <= 1 Integer
0 <= x_(17,_44) <= 1 Integer
0 <= x_(17,_45) <= 1 Integer
0 <= x_(17,_46) <= 1 Integer
0 <= x_(17,_47) <= 1 Integer
0 <= x_(17,_48) <= 1 Integer
0 <= x_(17,_49) <= 1 Integer
0 <= x_(17,_5) <= 1 Integer
0 <= x_(17,_6) <= 1 Integer
0 <= x_(17,_7) <= 1 Integer
0 <= x_(17,_8) <= 1 Integer
0 <= x_(17,_9) <= 1 Integer
0 <= x_(18,_0) <= 1 Integer
0 <= x_(18,_1) <= 1 Integer
0 <= x_(18,_10) <= 1 Integer
0 <= x_(18,_11) <= 1 Integer
0 <= x_(18,_12) <= 1 Integer
```

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0 <= x_(18,_13) <= 1 Integer
0 <= x_(18,_14) <= 1 Integer
0 <= x_(18,_15) <= 1 Integer
0 <= x_(18,_16) <= 1 Integer
0 <= x_(18,_17) <= 1 Integer
0 <= x_(18,_19) <= 1 Integer
0 <= x_(18,_2) <= 1 Integer
0 <= x_(18,_20) <= 1 Integer
0 <= x_(18,_21) <= 1 Integer
0 <= x_(18,_22) <= 1 Integer
0 <= x_(18,_23) <= 1 Integer
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0 <= x_(18,_3) <= 1 Integer
0 <= x_(18,_30) <= 1 Integer
0 <= x_(18,_31) <= 1 Integer
0 <= x_(18,_32) <= 1 Integer
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0 <= x_(18,_35) <= 1 Integer
0 <= x_(18,_36) <= 1 Integer
0 <= x_(18,_37) <= 1 Integer
0 <= x_(18,_38) <= 1 Integer
0 <= x_(18,_39) <= 1 Integer
0 <= x_(18,_4) <= 1 Integer
0 <= x_(18,_40) <= 1 Integer
0 <= x_(18,_41) <= 1 Integer
0 <= x_(18,_42) <= 1 Integer
0 <= x_(18,_43) <= 1 Integer
0 <= x_(18,_44) <= 1 Integer
0 <= x_(18,_45) <= 1 Integer
0 <= x_(18,_46) <= 1 Integer
0 <= x_(18,_47) <= 1 Integer
0 <= x_(18,_48) <= 1 Integer
0 <= x_(18,_49) <= 1 Integer
0 <= x_(18,_5) <= 1 Integer
0 <= x_(18,_6) <= 1 Integer
0 <= x_(18,_7) <= 1 Integer
0 <= x_(18,_8) <= 1 Integer
0 <= x_(18,_9) <= 1 Integer
0 <= x_(19,_0) <= 1 Integer
0 <= x_(19,_1) <= 1 Integer
0 <= x_(19,_10) <= 1 Integer
```

```
0 <= x_(19,_11) <= 1 Integer
0 <= x_(19,_12) <= 1 Integer
0 <= x_(19,_13) <= 1 Integer
0 <= x_(19,_14) <= 1 Integer
0 <= x_(19,_15) <= 1 Integer
0 <= x_(19,_16) <= 1 Integer
0 <= x_(19,_17) <= 1 Integer
0 <= x_(19,_18) <= 1 Integer
0 <= x_(19,_2) <= 1 Integer
0 <= x_(19,_20) <= 1 Integer
0 <= x_(19,_21) <= 1 Integer
0 <= x_(19,_22) <= 1 Integer
0 <= x_(19,_23) <= 1 Integer
0 <= x_(19,_24) <= 1 Integer
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0 <= x_(19,_27) <= 1 Integer
0 <= x_(19,_28) <= 1 Integer
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0 <= x_(19,_35) <= 1 Integer
0 <= x_(19,_36) <= 1 Integer
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0 <= x_(19,_38) <= 1 Integer
0 <= x_(19,_39) <= 1 Integer
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0 <= x_(19,_41) <= 1 Integer
0 <= x_(19,_42) <= 1 Integer
0 <= x_(19,_43) <= 1 Integer
0 <= x_(19,_44) <= 1 Integer
0 <= x_(19,_45) <= 1 Integer
0 <= x_(19,_46) <= 1 Integer
0 <= x_(19,_47) <= 1 Integer
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0 <= x_(19,_49) <= 1 Integer
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0 <= x_(19,_6) <= 1 Integer
0 <= x_(19,_7) <= 1 Integer
0 <= x_(19,_8) <= 1 Integer
0 <= x_(19,_9) <= 1 Integer
0 <= x_(2,_0) <= 1 Integer
```

```
0 <= x_(2,_1) <= 1 Integer
0 <= x_(2,_10) <= 1 Integer
0 <= x_(2,_11) <= 1 Integer
0 <= x_(2,_12) <= 1 Integer
0 <= x_(2,_13) <= 1 Integer
0 <= x_(2,_14) <= 1 Integer
0 <= x_(2,_15) <= 1 Integer
0 <= x_(2,_16) <= 1 Integer
0 <= x_(2,_17) <= 1 Integer
0 <= x_(2,_18) <= 1 Integer
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0 <= x_(2,_20) <= 1 Integer
0 <= x_(2,_21) <= 1 Integer
0 <= x_(2,_22) <= 1 Integer
0 <= x_(2,_23) <= 1 Integer
0 <= x_(2,_24) <= 1 Integer
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0 <= x_(2,_26) <= 1 Integer
0 <= x_(2,_27) <= 1 Integer
0 <= x_(2,_28) <= 1 Integer
0 <= x_(2,_29) <= 1 Integer
0 <= x_(2,_3) <= 1 Integer
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0 <= x_(2,_33) <= 1 Integer
0 <= x_(2,_34) <= 1 Integer
0 <= x_(2,_35) <= 1 Integer
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0 <= x_(2,_44) <= 1 Integer
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0 <= x_(2,_5) <= 1 Integer
0 <= x_(2,_6) <= 1 Integer
0 <= x_(2,_7) <= 1 Integer
0 <= x_(2,_8) <= 1 Integer
```

```
0 <= x_(2,_9) <= 1 Integer
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0 <= x_(20,_10) <= 1 Integer
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0 <= x_(20,_42) <= 1 Integer
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0 <= x_(20,_48) <= 1 Integer
0 <= x_(20,_49) <= 1 Integer
0 <= x_(20,_5) <= 1 Integer
0 <= x_(20,_6) <= 1 Integer
```

```
0 <= x_(20,_7) <= 1 Integer
0 <= x_(20,_8) <= 1 Integer
0 <= x_(20,_9) <= 1 Integer
0 <= x_(21,_0) <= 1 Integer
0 <= x_(21,_1) <= 1 Integer
0 <= x_(21,_10) <= 1 Integer
0 <= x_(21,_11) <= 1 Integer
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0 <= x_(21,_14) <= 1 Integer
0 <= x_(21,_15) <= 1 Integer
0 <= x_(21,_16) <= 1 Integer
0 <= x_(21,_17) <= 1 Integer
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0 <= x_(21,_23) <= 1 Integer
0 <= x_(21,_24) <= 1 Integer
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0 <= x_(21,_26) <= 1 Integer
0 <= x_(21,_27) <= 1 Integer
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0 <= x_(21,_3) <= 1 Integer
0 <= x_(21,_30) <= 1 Integer
0 <= x_(21,_31) <= 1 Integer
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0 <= x_(21,_33) <= 1 Integer
0 <= x_(21,_34) <= 1 Integer
0 <= x_(21,_35) <= 1 Integer
0 <= x_(21,_36) <= 1 Integer
0 <= x_(21,_37) <= 1 Integer
0 <= x_(21,_38) <= 1 Integer
0 <= x_(21,_39) <= 1 Integer
0 <= x_(21,_4) <= 1 Integer
0 <= x_(21,_40) <= 1 Integer
0 <= x_(21,_41) <= 1 Integer
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0 <= x_(21,_44) <= 1 Integer
0 <= x_(21,_45) <= 1 Integer
0 <= x_(21,_46) <= 1 Integer
0 <= x_(21,_47) <= 1 Integer
0 <= x_(21,_48) <= 1 Integer
0 <= x_(21,_49) <= 1 Integer
```

```
0 <= x_(21,_5) <= 1 Integer
0 <= x_(21,_6) <= 1 Integer
0 <= x_(21,_7) <= 1 Integer
0 <= x_(21,_8) <= 1 Integer
0 <= x_(21,_9) <= 1 Integer
0 <= x_(22,_0) <= 1 Integer
0 <= x_(22,_1) <= 1 Integer
0 <= x_(22,_10) <= 1 Integer
0 <= x_(22,_11) <= 1 Integer
0 <= x_(22,_12) <= 1 Integer
0 <= x_(22,_13) <= 1 Integer
0 <= x_(22,_14) <= 1 Integer
0 <= x_(22,_15) <= 1 Integer
0 <= x_(22,_16) <= 1 Integer
0 <= x_(22,_17) <= 1 Integer
0 <= x_(22,_18) <= 1 Integer
0 <= x_(22,_19) <= 1 Integer
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0 <= x_(22,_20) <= 1 Integer
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0 <= x_(22,_26) <= 1 Integer
0 <= x_(22,_27) <= 1 Integer
0 <= x_(22,_28) <= 1 Integer
0 <= x_(22,_29) <= 1 Integer
0 <= x_(22,_3) <= 1 Integer
0 <= x_(22,_30) <= 1 Integer
0 <= x_(22,_31) <= 1 Integer
0 <= x_(22,_32) <= 1 Integer
0 <= x_(22,_33) <= 1 Integer
0 <= x_(22,_34) <= 1 Integer
0 <= x_(22,_35) <= 1 Integer
0 <= x_(22,_36) <= 1 Integer
0 <= x_(22,_37) <= 1 Integer
0 <= x_(22,_38) <= 1 Integer
0 <= x_(22,_39) <= 1 Integer
0 <= x_(22,_4) <= 1 Integer
0 <= x_(22,_40) <= 1 Integer
0 <= x_(22,_41) <= 1 Integer
0 <= x_(22,_42) <= 1 Integer
0 <= x_(22,_43) <= 1 Integer
0 <= x_(22,_44) <= 1 Integer
0 <= x_(22,_45) <= 1 Integer
0 <= x_(22,_46) <= 1 Integer
0 <= x_(22,_47) <= 1 Integer
```

```
0 <= x_(22,_48) <= 1 Integer
0 <= x_(22,_49) <= 1 Integer
0 <= x_(22,_5) <= 1 Integer
0 <= x_(22,_6) <= 1 Integer
0 <= x_(22,_7) <= 1 Integer
0 <= x_(22,_8) <= 1 Integer
0 <= x_(22,_9) <= 1 Integer
0 <= x_(23,_0) <= 1 Integer
0 <= x_(23,_1) <= 1 Integer
0 <= x_(23,_10) <= 1 Integer
0 <= x_(23,_11) <= 1 Integer
0 <= x_(23,_12) <= 1 Integer
0 <= x_(23,_13) <= 1 Integer
0 <= x_(23,_14) <= 1 Integer
0 <= x_(23,_15) <= 1 Integer
0 <= x_(23,_16) <= 1 Integer
0 <= x_(23,_17) <= 1 Integer
0 <= x_(23,_18) <= 1 Integer
0 <= x_(23,_19) <= 1 Integer
0 <= x_(23,_2) <= 1 Integer
0 <= x_(23,_20) <= 1 Integer
0 <= x_(23,_21) <= 1 Integer
0 <= x_(23,_22) <= 1 Integer
0 <= x_(23,_24) <= 1 Integer
0 <= x_(23,_25) <= 1 Integer
0 <= x_(23,_26) <= 1 Integer
0 <= x_(23,_27) <= 1 Integer
0 <= x_(23,_28) <= 1 Integer
0 <= x_(23,_29) <= 1 Integer
0 <= x_(23,_3) <= 1 Integer
0 <= x_(23,_30) <= 1 Integer
0 <= x_(23,_31) <= 1 Integer
0 <= x_(23,_32) <= 1 Integer
0 <= x_(23,_33) <= 1 Integer
0 <= x_(23,_34) <= 1 Integer
0 <= x_(23,_35) <= 1 Integer
0 <= x_(23,_36) <= 1 Integer
0 <= x_(23,_37) <= 1 Integer
0 <= x_(23,_38) <= 1 Integer
0 <= x_(23,_39) <= 1 Integer
0 <= x_(23,_4) <= 1 Integer
0 <= x_(23,_40) <= 1 Integer
0 <= x_(23,_41) <= 1 Integer
0 <= x_(23,_42) <= 1 Integer
0 <= x_(23,_43) <= 1 Integer
0 <= x_(23,_44) <= 1 Integer
0 <= x_(23,_45) <= 1 Integer
```

```
0 <= x_(23,_46) <= 1 Integer
0 <= x_(23,_47) <= 1 Integer
0 <= x_(23,_48) <= 1 Integer
0 <= x_(23,_49) <= 1 Integer
0 <= x_(23,_5) <= 1 Integer
0 <= x_(23,_6) <= 1 Integer
0 <= x_(23,_7) <= 1 Integer
0 <= x_(23,_8) <= 1 Integer
0 <= x_(23,_9) <= 1 Integer
0 <= x_(24,_0) <= 1 Integer
0 <= x_(24,_1) <= 1 Integer
0 <= x_(24,_10) <= 1 Integer
0 <= x_(24,_11) <= 1 Integer
0 <= x_(24,_12) <= 1 Integer
0 <= x_(24,_13) <= 1 Integer
0 <= x_(24,_14) <= 1 Integer
0 <= x_(24,_15) <= 1 Integer
0 <= x_(24,_16) <= 1 Integer
0 <= x_(24,_17) <= 1 Integer
0 <= x_(24,_18) <= 1 Integer
0 <= x_(24,_19) <= 1 Integer
0 <= x_(24,_2) <= 1 Integer
0 <= x_(24,_20) <= 1 Integer
0 <= x_(24,_21) <= 1 Integer
0 <= x_(24,_22) <= 1 Integer
0 <= x_(24,_23) <= 1 Integer
0 <= x_(24,_25) <= 1 Integer
0 <= x_(24,_26) <= 1 Integer
0 <= x_(24,_27) <= 1 Integer
0 <= x_(24,_28) <= 1 Integer
0 <= x_(24,_29) <= 1 Integer
0 <= x_(24,_3) <= 1 Integer
0 <= x_(24,_30) <= 1 Integer
0 <= x_(24,_31) <= 1 Integer
0 <= x_(24,_32) <= 1 Integer
0 <= x_(24,_33) <= 1 Integer
0 <= x_(24,_34) <= 1 Integer
0 <= x_(24,_35) <= 1 Integer
0 <= x_(24,_36) <= 1 Integer
0 <= x_(24,_37) <= 1 Integer
0 <= x_(24,_38) <= 1 Integer
0 <= x_(24,_39) <= 1 Integer
0 <= x_(24,_4) <= 1 Integer
0 <= x_(24,_40) <= 1 Integer
0 <= x_(24,_41) <= 1 Integer
0 <= x_(24,_42) <= 1 Integer
0 <= x_(24,_43) <= 1 Integer
```

```
0 <= x_(24,_44) <= 1 Integer
0 <= x_(24,_45) <= 1 Integer
0 <= x_(24,_46) <= 1 Integer
0 <= x_(24,_47) <= 1 Integer
0 <= x_(24,_48) <= 1 Integer
0 <= x_(24,_49) <= 1 Integer
0 <= x_(24,_5) <= 1 Integer
0 <= x_(24,_6) <= 1 Integer
0 <= x_(24,_7) <= 1 Integer
0 <= x_(24,_8) <= 1 Integer
0 <= x_(24,_9) <= 1 Integer
0 <= x_(25,_0) <= 1 Integer
0 <= x_(25,_1) <= 1 Integer
0 <= x_(25,_10) <= 1 Integer
0 <= x_(25,_11) <= 1 Integer
0 <= x_(25,_12) <= 1 Integer
0 <= x_(25,_13) <= 1 Integer
0 <= x_(25,_14) <= 1 Integer
0 <= x_(25,_15) <= 1 Integer
0 <= x_(25,_16) <= 1 Integer
0 <= x_(25,_17) <= 1 Integer
0 <= x_(25,_18) <= 1 Integer
0 <= x_(25,_19) <= 1 Integer
0 <= x_(25,_2) <= 1 Integer
0 <= x_(25,_20) <= 1 Integer
0 <= x_(25,_21) <= 1 Integer
0 <= x_(25,_22) <= 1 Integer
0 <= x_(25,_23) <= 1 Integer
0 <= x_(25,_24) <= 1 Integer
0 <= x_(25,_26) <= 1 Integer
0 <= x_(25,_27) <= 1 Integer
0 <= x_(25,_28) <= 1 Integer
0 <= x_(25,_29) <= 1 Integer
0 <= x_(25,_3) <= 1 Integer
0 <= x_(25,_30) <= 1 Integer
0 <= x_(25,_31) <= 1 Integer
0 <= x_(25,_32) <= 1 Integer
0 <= x_(25,_33) <= 1 Integer
0 <= x_(25,_34) <= 1 Integer
0 <= x_(25,_35) <= 1 Integer
0 <= x_(25,_36) <= 1 Integer
0 <= x_(25,_37) <= 1 Integer
0 <= x_(25,_38) <= 1 Integer
0 <= x_(25,_39) <= 1 Integer
0 <= x_(25,_4) <= 1 Integer
0 <= x_(25,_40) <= 1 Integer
0 <= x_(25,_41) <= 1 Integer
```

```
0 <= x_(25,_42) <= 1 Integer
0 <= x_(25,_43) <= 1 Integer
0 <= x_(25,_44) <= 1 Integer
0 <= x_(25,_45) <= 1 Integer
0 <= x_(25,_46) <= 1 Integer
0 <= x_(25,_47) <= 1 Integer
0 <= x_(25,_48) <= 1 Integer
0 <= x_(25,_49) <= 1 Integer
0 <= x_(25,_5) <= 1 Integer
0 <= x_(25,_6) <= 1 Integer
0 <= x_(25,_7) <= 1 Integer
0 <= x_(25,_8) <= 1 Integer
0 <= x_(25,_9) <= 1 Integer
0 <= x_(26,_0) <= 1 Integer
0 <= x_(26,_1) <= 1 Integer
0 <= x_(26,_10) <= 1 Integer
0 <= x_(26,_11) <= 1 Integer
0 <= x_(26,_12) <= 1 Integer
0 <= x_(26,_13) <= 1 Integer
0 <= x_(26,_14) <= 1 Integer
0 <= x_(26,_15) <= 1 Integer
0 <= x_(26,_16) <= 1 Integer
0 <= x_(26,_17) <= 1 Integer
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0 <= x_(26,_21) <= 1 Integer
0 <= x_(26,_22) <= 1 Integer
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0 <= x_(26,_24) <= 1 Integer
0 <= x_(26,_25) <= 1 Integer
0 <= x_(26,_27) <= 1 Integer
0 <= x_(26,_28) <= 1 Integer
0 <= x_(26,_29) <= 1 Integer
0 <= x_(26,_3) <= 1 Integer
0 <= x_(26,_30) <= 1 Integer
0 <= x_(26,_31) <= 1 Integer
0 <= x_(26,_32) <= 1 Integer
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0 <= x_(26,_34) <= 1 Integer
0 <= x_(26,_35) <= 1 Integer
0 <= x_(26,_36) <= 1 Integer
0 <= x_(26,_37) <= 1 Integer
0 <= x_(26,_38) <= 1 Integer
0 <= x_(26,_39) <= 1 Integer
0 <= x_(26,_4) <= 1 Integer
```

```
0 <= x_(26,_40) <= 1 Integer
0 <= x_(26,_41) <= 1 Integer
0 <= x_(26,_42) <= 1 Integer
0 <= x_(26,_43) <= 1 Integer
0 <= x_(26,_44) <= 1 Integer
0 <= x_(26,_45) <= 1 Integer
0 <= x_(26,_46) <= 1 Integer
0 <= x_(26,_47) <= 1 Integer
0 <= x_(26,_48) <= 1 Integer
0 <= x_(26,_49) <= 1 Integer
0 <= x_(26,_5) <= 1 Integer
0 <= x_(26,_6) <= 1 Integer
0 <= x_(26,_7) <= 1 Integer
0 <= x_(26,_8) <= 1 Integer
0 <= x_(26,_9) <= 1 Integer
0 <= x_(27,_0) <= 1 Integer
0 <= x_(27,_1) <= 1 Integer
0 <= x_(27,_10) <= 1 Integer
0 <= x_(27,_11) <= 1 Integer
0 <= x_(27,_12) <= 1 Integer
0 <= x_(27,_13) <= 1 Integer
0 <= x_(27,_14) <= 1 Integer
0 <= x_(27,_15) <= 1 Integer
0 <= x_(27,_16) <= 1 Integer
0 <= x_(27,_17) <= 1 Integer
0 <= x_(27,_18) <= 1 Integer
0 <= x_(27,_19) <= 1 Integer
0 <= x_(27,_2) <= 1 Integer
0 <= x_(27,_20) <= 1 Integer
0 <= x_(27,_21) <= 1 Integer
0 <= x_(27,_22) <= 1 Integer
0 <= x_(27,_23) <= 1 Integer
0 <= x_(27,_24) <= 1 Integer
0 <= x_(27,_25) <= 1 Integer
0 <= x_(27,_26) <= 1 Integer
0 <= x_(27,_28) <= 1 Integer
0 <= x_(27,_29) <= 1 Integer
0 <= x_(27,_3) <= 1 Integer
0 <= x_(27,_30) <= 1 Integer
0 <= x_(27,_31) <= 1 Integer
0 <= x_(27,_32) <= 1 Integer
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0 <= x_(27,_34) <= 1 Integer
0 <= x_(27,_35) <= 1 Integer
0 <= x_(27,_36) <= 1 Integer
0 <= x_(27,_37) <= 1 Integer
0 <= x_(27,_38) <= 1 Integer
```

```
0 <= x_(27,_39) <= 1 Integer
0 <= x_(27,_4) <= 1 Integer
0 <= x_(27,_40) <= 1 Integer
0 <= x_(27,_41) <= 1 Integer
0 <= x_(27,_42) <= 1 Integer
0 <= x_(27,_43) <= 1 Integer
0 <= x_(27,_44) <= 1 Integer
0 <= x_(27,_45) <= 1 Integer
0 <= x_(27,_46) <= 1 Integer
0 <= x_(27,_47) <= 1 Integer
0 <= x_(27,_48) <= 1 Integer
0 <= x_(27,_49) <= 1 Integer
0 <= x_(27,_5) <= 1 Integer
0 <= x_(27,_6) <= 1 Integer
0 <= x_(27,_7) <= 1 Integer
0 <= x_(27,_8) <= 1 Integer
0 <= x_(27,_9) <= 1 Integer
0 <= x_(28,_0) <= 1 Integer
0 <= x_(28,_1) <= 1 Integer
0 <= x_(28,_10) <= 1 Integer
0 <= x_(28,_11) <= 1 Integer
0 <= x_(28,_12) <= 1 Integer
0 <= x_(28,_13) <= 1 Integer
0 <= x_(28,_14) <= 1 Integer
0 <= x_(28,_15) <= 1 Integer
0 <= x_(28,_16) <= 1 Integer
0 <= x_(28,_17) <= 1 Integer
0 <= x_(28,_18) <= 1 Integer
0 <= x_(28,_19) <= 1 Integer
0 <= x_(28,_2) <= 1 Integer
0 <= x_(28,_20) <= 1 Integer
0 <= x_(28,_21) <= 1 Integer
0 <= x_(28,_22) <= 1 Integer
0 <= x_(28,_23) <= 1 Integer
0 <= x_(28,_24) <= 1 Integer
0 <= x_(28,_25) <= 1 Integer
0 <= x_(28,_26) <= 1 Integer
0 <= x_(28,_27) <= 1 Integer
0 <= x_(28,_29) <= 1 Integer
0 <= x_(28,_3) <= 1 Integer
0 <= x_(28,_30) <= 1 Integer
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0 <= x_(28,_33) <= 1 Integer
0 <= x_(28,_34) <= 1 Integer
0 <= x_(28,_35) <= 1 Integer
0 <= x_(28,_36) <= 1 Integer
```

```
0 <= x_(28,_37) <= 1 Integer
0 <= x_(28,_38) <= 1 Integer
0 <= x_(28,_39) <= 1 Integer
0 <= x_(28,_4) <= 1 Integer
0 <= x_(28,_40) <= 1 Integer
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0 <= x_(28,_44) <= 1 Integer
0 <= x_(28,_45) <= 1 Integer
0 <= x_(28,_46) <= 1 Integer
0 <= x_(28,_47) <= 1 Integer
0 <= x_(28,_48) <= 1 Integer
0 <= x_(28,_49) <= 1 Integer
0 <= x_(28,_5) <= 1 Integer
0 <= x_(28,_6) <= 1 Integer
0 <= x_(28,_7) <= 1 Integer
0 <= x_(28,_8) <= 1 Integer
0 <= x_(28,_9) <= 1 Integer
0 <= x_(29,_0) <= 1 Integer
0 <= x_(29,_1) <= 1 Integer
0 <= x_(29,_10) <= 1 Integer
0 <= x_(29,_11) <= 1 Integer
0 <= x_(29,_12) <= 1 Integer
0 <= x_(29,_13) <= 1 Integer
0 <= x_(29,_14) <= 1 Integer
0 <= x_(29,_15) <= 1 Integer
0 <= x_(29,_16) <= 1 Integer
0 <= x_(29,_17) <= 1 Integer
0 <= x_(29,_18) <= 1 Integer
0 <= x_(29,_19) <= 1 Integer
0 <= x_(29,_2) <= 1 Integer
0 <= x_(29,_20) <= 1 Integer
0 <= x_(29,_21) <= 1 Integer
0 <= x_(29,_22) <= 1 Integer
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0 <= x_(29,_24) <= 1 Integer
0 <= x_(29,_25) <= 1 Integer
0 <= x_(29,_26) <= 1 Integer
0 <= x_(29,_27) <= 1 Integer
0 <= x_(29,_28) <= 1 Integer
0 <= x_(29,_3) <= 1 Integer
0 <= x_(29,_30) <= 1 Integer
0 <= x_(29,_31) <= 1 Integer
0 <= x_(29,_32) <= 1 Integer
0 <= x_(29,_33) <= 1 Integer
0 <= x_(29,_34) <= 1 Integer
```

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0 <= x_(29,_35) <= 1 Integer
0 <= x_(29,_36) <= 1 Integer
0 <= x_(29,_37) <= 1 Integer
0 <= x_(29,_38) <= 1 Integer
0 <= x_(29,_39) <= 1 Integer
0 <= x_(29,_4) <= 1 Integer
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0 <= x_(29,_46) <= 1 Integer
0 <= x_(29,_47) <= 1 Integer
0 <= x_(29,_48) <= 1 Integer
0 <= x_(29,_49) <= 1 Integer
0 <= x_(29,_5) <= 1 Integer
0 <= x_(29,_6) <= 1 Integer
0 <= x_(29,_7) <= 1 Integer
0 <= x_(29,_8) <= 1 Integer
0 <= x_(29,_9) <= 1 Integer
0 <= x_(3,_0) <= 1 Integer
0 <= x_(3,_1) <= 1 Integer
0 <= x_(3,_10) <= 1 Integer
0 <= x_(3,_11) <= 1 Integer
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0 <= x_(3,_16) <= 1 Integer
0 <= x_(3,_17) <= 1 Integer
0 <= x_(3,_18) <= 1 Integer
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0 <= x_(3,_28) <= 1 Integer
0 <= x_(3,_29) <= 1 Integer
0 <= x_(3,_30) <= 1 Integer
0 <= x_(3,_31) <= 1 Integer
0 <= x_(3,_32) <= 1 Integer
```

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0 <= x_(3,_33) <= 1 Integer
0 <= x_(3,_34) <= 1 Integer
0 <= x_(3,_35) <= 1 Integer
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0 <= x_(3,_37) <= 1 Integer
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0 <= x_(3,_6) <= 1 Integer
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0 <= x_(3,_9) <= 1 Integer
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0 <= x_(30,_15) <= 1 Integer
0 <= x_(30,_16) <= 1 Integer
0 <= x_(30,_17) <= 1 Integer
0 <= x_(30,_18) <= 1 Integer
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0 <= x_(30,_26) <= 1 Integer
0 <= x_(30,_27) <= 1 Integer
0 <= x_(30,_28) <= 1 Integer
0 <= x_(30,_29) <= 1 Integer
0 <= x_(30,_3) <= 1 Integer
```

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0 <= x_(30,_31) <= 1 Integer
0 <= x_(30,_32) <= 1 Integer
0 <= x_(30,_33) <= 1 Integer
0 <= x_(30,_34) <= 1 Integer
0 <= x_(30,_35) <= 1 Integer
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0 <= x_(30,_37) <= 1 Integer
0 <= x_(30,_38) <= 1 Integer
0 <= x_(30,_39) <= 1 Integer
0 <= x_(30,_4) <= 1 Integer
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0 <= x_(30,_7) <= 1 Integer
0 <= x_(30,_8) <= 1 Integer
0 <= x_(30,_9) <= 1 Integer
0 <= x_(31,_0) <= 1 Integer
0 <= x_(31,_1) <= 1 Integer
0 <= x_(31,_10) <= 1 Integer
0 <= x_(31,_11) <= 1 Integer
0 <= x_(31,_12) <= 1 Integer
0 <= x_(31,_13) <= 1 Integer
0 <= x_(31,_14) <= 1 Integer
0 <= x_(31,_15) <= 1 Integer
0 <= x_(31,_16) <= 1 Integer
0 <= x_(31,_17) <= 1 Integer
0 <= x_(31,_18) <= 1 Integer
0 <= x_(31,_19) <= 1 Integer
0 <= x_(31,_2) <= 1 Integer
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0 <= x_(31,_24) <= 1 Integer
0 <= x_(31,_25) <= 1 Integer
0 <= x_(31,_26) <= 1 Integer
0 <= x_(31,_27) <= 1 Integer
0 <= x_(31,_28) <= 1 Integer
```

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0 <= x_(31,_29) <= 1 Integer
0 <= x_(31,_3) <= 1 Integer
0 <= x_(31,_30) <= 1 Integer
0 <= x_(31,_32) <= 1 Integer
0 <= x_(31,_33) <= 1 Integer
0 <= x_(31,_34) <= 1 Integer
0 <= x_(31,_35) <= 1 Integer
0 <= x_(31,_36) <= 1 Integer
0 <= x_(31,_37) <= 1 Integer
0 <= x_(31,_38) <= 1 Integer
0 <= x_(31,_39) <= 1 Integer
0 <= x_(31,_4) <= 1 Integer
0 <= x_(31,_40) <= 1 Integer
0 <= x_(31,_41) <= 1 Integer
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0 <= x_(31,_7) <= 1 Integer
0 <= x_(31,_8) <= 1 Integer
0 <= x_(31,_9) <= 1 Integer
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0 <= x_(32,_11) <= 1 Integer
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0 <= x_(32,_13) <= 1 Integer
0 <= x_(32,_14) <= 1 Integer
0 <= x_(32,_15) <= 1 Integer
0 <= x_(32,_16) <= 1 Integer
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0 <= x_(32,_19) <= 1 Integer
0 <= x_(32,_2) <= 1 Integer
0 <= x_(32,_20) <= 1 Integer
0 <= x_(32,_21) <= 1 Integer
0 <= x_(32,_22) <= 1 Integer
0 <= x_(32,_23) <= 1 Integer
0 <= x_(32,_24) <= 1 Integer
0 <= x_(32,_25) <= 1 Integer
0 <= x_(32,_26) <= 1 Integer
```

```
0 <= x_(32,_27) <= 1 Integer
0 <= x_(32,_28) <= 1 Integer
0 <= x_(32,_29) <= 1 Integer
0 <= x_(32,_3) <= 1 Integer
0 <= x_(32,_30) <= 1 Integer
0 <= x_(32,_31) <= 1 Integer
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0 <= x_(32,_37) <= 1 Integer
0 <= x_(32,_38) <= 1 Integer
0 <= x_(32,_39) <= 1 Integer
0 <= x_(32,_4) <= 1 Integer
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0 <= x_(32,_41) <= 1 Integer
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0 <= x_(32,_6) <= 1 Integer
0 <= x_(32,_7) <= 1 Integer
0 <= x_(32,_8) <= 1 Integer
0 <= x_(32,_9) <= 1 Integer
0 <= x_(33,_0) <= 1 Integer
0 <= x_(33,_1) <= 1 Integer
0 <= x_(33,_10) <= 1 Integer
0 <= x_(33,_11) <= 1 Integer
0 <= x_(33,_12) <= 1 Integer
0 <= x_(33,_13) <= 1 Integer
0 <= x_(33,_14) <= 1 Integer
0 <= x_(33,_15) <= 1 Integer
0 <= x_(33,_16) <= 1 Integer
0 <= x_(33,_17) <= 1 Integer
0 <= x_(33,_18) <= 1 Integer
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0 <= x_(33,_21) <= 1 Integer
0 <= x_(33,_22) <= 1 Integer
0 <= x_(33,_23) <= 1 Integer
0 <= x_(33,_24) <= 1 Integer
```

```
0 <= x_(33,_25) <= 1 Integer
0 <= x_(33,_26) <= 1 Integer
0 <= x_(33,_27) <= 1 Integer
0 <= x_(33,_28) <= 1 Integer
0 <= x_(33,_29) <= 1 Integer
0 <= x_(33,_3) <= 1 Integer
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0 <= x_(33,_37) <= 1 Integer
0 <= x_(33,_38) <= 1 Integer
0 <= x_(33,_39) <= 1 Integer
0 <= x_(33,_4) <= 1 Integer
0 <= x_(33,_40) <= 1 Integer
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0 <= x_(33,_5) <= 1 Integer
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0 <= x_(33,_7) <= 1 Integer
0 <= x_(33,_8) <= 1 Integer
0 <= x_(33,_9) <= 1 Integer
0 <= x_(34,_0) <= 1 Integer
0 <= x_(34,_1) <= 1 Integer
0 <= x_(34,_10) <= 1 Integer
0 <= x_(34,_11) <= 1 Integer
0 <= x_(34,_12) <= 1 Integer
0 <= x_(34,_13) <= 1 Integer
0 <= x_(34,_14) <= 1 Integer
0 <= x_(34,_15) <= 1 Integer
0 <= x_(34,_16) <= 1 Integer
0 <= x_(34,_17) <= 1 Integer
0 <= x_(34,_18) <= 1 Integer
0 <= x_(34,_19) <= 1 Integer
0 <= x_(34,_2) <= 1 Integer
0 <= x_(34,_20) <= 1 Integer
0 <= x_(34,_21) <= 1 Integer
0 <= x_(34,_22) <= 1 Integer
```

```
0 <= x_(34,_23) <= 1 Integer
0 <= x_(34,_24) <= 1 Integer
0 <= x_(34,_25) <= 1 Integer
0 <= x_(34,_26) <= 1 Integer
0 <= x_(34,_27) <= 1 Integer
0 <= x_(34,_28) <= 1 Integer
0 <= x_(34,_29) <= 1 Integer
0 <= x_(34,_3) <= 1 Integer
0 <= x_(34,_30) <= 1 Integer
0 <= x_(34,_31) <= 1 Integer
0 <= x_(34,_32) <= 1 Integer
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0 <= x_(34,_35) <= 1 Integer
0 <= x_(34,_36) <= 1 Integer
0 <= x_(34,_37) <= 1 Integer
0 <= x_(34,_38) <= 1 Integer
0 <= x_(34,_39) <= 1 Integer
0 <= x_(34,_4) <= 1 Integer
0 <= x_(34,_40) <= 1 Integer
0 <= x_(34,_41) <= 1 Integer
0 <= x_(34,_42) <= 1 Integer
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0 <= x_(34,_46) <= 1 Integer
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0 <= x_(34,_49) <= 1 Integer
0 <= x_(34,_5) <= 1 Integer
0 <= x_(34,_6) <= 1 Integer
0 <= x_(34,_7) <= 1 Integer
0 <= x_(34,_8) <= 1 Integer
0 <= x_(34,_9) <= 1 Integer
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0 <= x_(35,_1) <= 1 Integer
0 <= x_(35,_10) <= 1 Integer
0 <= x_(35,_11) <= 1 Integer
0 <= x_(35,_12) <= 1 Integer
0 <= x_(35,_13) <= 1 Integer
0 <= x_(35,_14) <= 1 Integer
0 <= x_(35,_15) <= 1 Integer
0 <= x_(35,_16) <= 1 Integer
0 <= x_(35,_17) <= 1 Integer
0 <= x_(35,_18) <= 1 Integer
0 <= x_(35,_19) <= 1 Integer
0 <= x_(35,_2) <= 1 Integer
0 <= x_(35,_20) <= 1 Integer
```

```
0 <= x_(35,_21) <= 1 Integer
0 <= x_(35,_22) <= 1 Integer
0 <= x_(35,_23) <= 1 Integer
0 <= x_(35,_24) <= 1 Integer
0 <= x_(35,_25) <= 1 Integer
0 <= x_(35,_26) <= 1 Integer
0 <= x_(35,_27) <= 1 Integer
0 <= x_(35,_28) <= 1 Integer
0 <= x_(35,_29) <= 1 Integer
0 <= x_(35,_3) <= 1 Integer
0 <= x_(35,_30) <= 1 Integer
0 <= x_(35,_31) <= 1 Integer
0 <= x_(35,_32) <= 1 Integer
0 <= x_(35,_33) <= 1 Integer
0 <= x_(35,_34) <= 1 Integer
0 <= x_(35,_36) <= 1 Integer
0 <= x_(35,_37) <= 1 Integer
0 <= x_(35,_38) <= 1 Integer
0 <= x_(35,_39) <= 1 Integer
0 <= x_(35,_4) <= 1 Integer
0 <= x_(35,_40) <= 1 Integer
0 <= x_(35,_41) <= 1 Integer
0 <= x_(35,_42) <= 1 Integer
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0 <= x_(35,_44) <= 1 Integer
0 <= x_(35,_45) <= 1 Integer
0 <= x_(35,_46) <= 1 Integer
0 <= x_(35,_47) <= 1 Integer
0 <= x_(35,_48) <= 1 Integer
0 <= x_(35,_49) <= 1 Integer
0 <= x_(35,_5) <= 1 Integer
0 <= x_(35,_6) <= 1 Integer
0 <= x_(35,_7) <= 1 Integer
0 <= x_(35,_8) <= 1 Integer
0 <= x_(35,_9) <= 1 Integer
0 <= x_(36,_0) <= 1 Integer
0 <= x_(36,_1) <= 1 Integer
0 <= x_(36,_10) <= 1 Integer
0 <= x_(36,_11) <= 1 Integer
0 <= x_(36,_12) <= 1 Integer
0 <= x_(36,_13) <= 1 Integer
0 <= x_(36,_14) <= 1 Integer
0 <= x_(36,_15) <= 1 Integer
0 <= x_(36,_16) <= 1 Integer
0 <= x_(36,_17) <= 1 Integer
0 <= x_(36,_18) <= 1 Integer
0 <= x_(36,_19) <= 1 Integer
```

```
0 <= x_(36,_2) <= 1 Integer
0 <= x_(36,_20) <= 1 Integer
0 <= x_(36,_21) <= 1 Integer
0 <= x_(36,_22) <= 1 Integer
0 <= x_(36,_23) <= 1 Integer
0 <= x_(36,_24) <= 1 Integer
0 <= x_(36,_25) <= 1 Integer
0 <= x_(36,_26) <= 1 Integer
0 <= x_(36,_27) <= 1 Integer
0 <= x_(36,_28) <= 1 Integer
0 <= x_(36,_29) <= 1 Integer
0 <= x_(36,_3) <= 1 Integer
0 <= x_(36,_30) <= 1 Integer
0 <= x_(36,_31) <= 1 Integer
0 <= x_(36,_32) <= 1 Integer
0 <= x_(36,_33) <= 1 Integer
0 <= x_(36,_34) <= 1 Integer
0 <= x_(36,_35) <= 1 Integer
0 <= x_(36,_37) <= 1 Integer
0 <= x_(36,_38) <= 1 Integer
0 <= x_(36,_39) <= 1 Integer
0 <= x_(36,_4) <= 1 Integer
0 <= x_(36,_40) <= 1 Integer
0 <= x_(36,_41) <= 1 Integer
0 <= x_(36,_42) <= 1 Integer
0 <= x_(36,_43) <= 1 Integer
0 <= x_(36,_44) <= 1 Integer
0 <= x_(36,_45) <= 1 Integer
0 <= x_(36,_46) <= 1 Integer
0 <= x_(36,_47) <= 1 Integer
0 <= x_(36,_48) <= 1 Integer
0 <= x_(36,_49) <= 1 Integer
0 <= x_(36,_5) <= 1 Integer
0 <= x_(36,_6) <= 1 Integer
0 <= x_(36,_7) <= 1 Integer
0 <= x_(36,_8) <= 1 Integer
0 <= x_(36,_9) <= 1 Integer
0 <= x_(37,_0) <= 1 Integer
0 <= x_(37,_1) <= 1 Integer
0 <= x_(37,_10) <= 1 Integer
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0 <= x_(37,_13) <= 1 Integer
0 <= x_(37,_14) <= 1 Integer
0 <= x_(37,_15) <= 1 Integer
0 <= x_(37,_16) <= 1 Integer
0 <= x_(37,_17) <= 1 Integer
```

```
0 <= x_(37,_18) <= 1 Integer
0 <= x_(37,_19) <= 1 Integer
0 <= x_(37,_2) <= 1 Integer
0 <= x_(37,_20) <= 1 Integer
0 <= x_(37,_21) <= 1 Integer
0 <= x_(37,_22) <= 1 Integer
0 <= x_(37,_23) <= 1 Integer
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0 <= x_(37,_30) <= 1 Integer
0 <= x_(37,_31) <= 1 Integer
0 <= x_(37,_32) <= 1 Integer
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0 <= x_(37,_34) <= 1 Integer
0 <= x_(37,_35) <= 1 Integer
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0 <= x_(37,_39) <= 1 Integer
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0 <= x_(37,_47) <= 1 Integer
0 <= x_(37,_48) <= 1 Integer
0 <= x_(37,_49) <= 1 Integer
0 <= x_(37,_5) <= 1 Integer
0 <= x_(37,_6) <= 1 Integer
0 <= x_(37,_7) <= 1 Integer
0 <= x_(37,_8) <= 1 Integer
0 <= x_(37,_9) <= 1 Integer
0 <= x_(38,_0) <= 1 Integer
0 <= x_(38,_1) <= 1 Integer
0 <= x_(38,_10) <= 1 Integer
0 <= x_(38,_11) <= 1 Integer
0 <= x_(38,_12) <= 1 Integer
0 <= x_(38,_13) <= 1 Integer
0 <= x_(38,_14) <= 1 Integer
0 <= x_(38,_15) <= 1 Integer
```

```
0 <= x_(38,_16) <= 1 Integer
0 <= x_(38,_17) <= 1 Integer
0 <= x_(38,_18) <= 1 Integer
0 <= x_(38,_19) <= 1 Integer
0 <= x_(38,_2) <= 1 Integer
0 <= x_(38,_20) <= 1 Integer
0 <= x_(38,_21) <= 1 Integer
0 <= x_(38,_22) <= 1 Integer
0 <= x_(38,_23) <= 1 Integer
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0 <= x_(38,_27) <= 1 Integer
0 <= x_(38,_28) <= 1 Integer
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0 <= x_(38,_3) <= 1 Integer
0 <= x_(38,_30) <= 1 Integer
0 <= x_(38,_31) <= 1 Integer
0 <= x_(38,_32) <= 1 Integer
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0 <= x_(38,_34) <= 1 Integer
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0 <= x_(38,_36) <= 1 Integer
0 <= x_(38,_37) <= 1 Integer
0 <= x_(38,_39) <= 1 Integer
0 <= x_(38,_4) <= 1 Integer
0 <= x_(38,_40) <= 1 Integer
0 <= x_(38,_41) <= 1 Integer
0 <= x_(38,_42) <= 1 Integer
0 <= x_(38,_43) <= 1 Integer
0 <= x_(38,_44) <= 1 Integer
0 <= x_(38,_45) <= 1 Integer
0 <= x_(38,_46) <= 1 Integer
0 <= x_(38,_47) <= 1 Integer
0 <= x_(38,_48) <= 1 Integer
0 <= x_(38,_49) <= 1 Integer
0 <= x_(38,_5) <= 1 Integer
0 <= x_(38,_6) <= 1 Integer
0 <= x_(38,_7) <= 1 Integer
0 <= x_(38,_8) <= 1 Integer
0 <= x_(38,_9) <= 1 Integer
0 <= x_(39,_0) <= 1 Integer
0 <= x_(39,_1) <= 1 Integer
0 <= x_(39,_10) <= 1 Integer
0 <= x_(39,_11) <= 1 Integer
0 <= x_(39,_12) <= 1 Integer
0 <= x_(39,_13) <= 1 Integer
```

```
0 <= x_(39,_14) <= 1 Integer
0 <= x_(39,_15) <= 1 Integer
0 <= x_(39,_16) <= 1 Integer
0 <= x_(39,_17) <= 1 Integer
0 <= x_(39,_18) <= 1 Integer
0 <= x_(39,_19) <= 1 Integer
0 <= x_(39,_2) <= 1 Integer
0 <= x_(39,_20) <= 1 Integer
0 <= x_(39,_21) <= 1 Integer
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0 <= x_(39,_27) <= 1 Integer
0 <= x_(39,_28) <= 1 Integer
0 <= x_(39,_29) <= 1 Integer
0 <= x_(39,_3) <= 1 Integer
0 <= x_(39,_30) <= 1 Integer
0 <= x_(39,_31) <= 1 Integer
0 <= x_(39,_32) <= 1 Integer
0 <= x_(39,_33) <= 1 Integer
0 <= x_(39,_34) <= 1 Integer
0 <= x_(39,_35) <= 1 Integer
0 <= x_(39,_36) <= 1 Integer
0 <= x_(39,_37) <= 1 Integer
0 <= x_(39,_38) <= 1 Integer
0 <= x_(39,_4) <= 1 Integer
0 <= x_(39,_40) <= 1 Integer
0 <= x_(39,_41) <= 1 Integer
0 <= x_(39,_42) <= 1 Integer
0 <= x_(39,_43) <= 1 Integer
0 <= x_(39,_44) <= 1 Integer
0 <= x_(39,_45) <= 1 Integer
0 <= x_(39,_46) <= 1 Integer
0 <= x_(39,_47) <= 1 Integer
0 <= x_(39,_48) <= 1 Integer
0 <= x_(39,_49) <= 1 Integer
0 <= x_(39,_5) <= 1 Integer
0 <= x_(39,_6) <= 1 Integer
0 <= x_(39,_7) <= 1 Integer
0 <= x_(39,_8) <= 1 Integer
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0 <= x_(4,_0) <= 1 Integer
0 <= x_(4,_1) <= 1 Integer
0 <= x_(4,_10) <= 1 Integer
0 <= x_(4,_11) <= 1 Integer
```

```
0 <= x_(4,_12) <= 1 Integer
0 <= x_(4,_13) <= 1 Integer
0 <= x_(4,_14) <= 1 Integer
0 <= x_(4,_15) <= 1 Integer
0 <= x_(4,_16) <= 1 Integer
0 <= x_(4,_17) <= 1 Integer
0 <= x_(4,_18) <= 1 Integer
0 <= x_(4,_19) <= 1 Integer
0 <= x_(4,_2) <= 1 Integer
0 <= x_(4,_20) <= 1 Integer
0 <= x_(4,_21) <= 1 Integer
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0 <= x_(4,_23) <= 1 Integer
0 <= x_(4,_24) <= 1 Integer
0 <= x_(4,_25) <= 1 Integer
0 <= x_(4,_26) <= 1 Integer
0 <= x_(4,_27) <= 1 Integer
0 <= x_(4,_28) <= 1 Integer
0 <= x_(4,_29) <= 1 Integer
0 <= x_(4,_3) <= 1 Integer
0 <= x_(4,_30) <= 1 Integer
0 <= x_(4,_31) <= 1 Integer
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0 <= x_(4,_35) <= 1 Integer
0 <= x_(4,_36) <= 1 Integer
0 <= x_(4,_37) <= 1 Integer
0 <= x_(4,_38) <= 1 Integer
0 <= x_(4,_39) <= 1 Integer
0 <= x_(4,_40) <= 1 Integer
0 <= x_(4,_41) <= 1 Integer
0 <= x_(4,_42) <= 1 Integer
0 <= x_(4,_43) <= 1 Integer
0 <= x_(4,_44) <= 1 Integer
0 <= x_(4,_45) <= 1 Integer
0 <= x_(4,_46) <= 1 Integer
0 <= x_(4,_47) <= 1 Integer
0 <= x_(4,_48) <= 1 Integer
0 <= x_(4,_49) <= 1 Integer
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0 <= x_(4,_7) <= 1 Integer
0 <= x_(4,_8) <= 1 Integer
0 <= x_(4,_9) <= 1 Integer
0 <= x_(40,_0) <= 1 Integer
0 <= x_(40,_1) <= 1 Integer
```

```
0 <= x_(40,_10) <= 1 Integer
0 <= x_(40,_11) <= 1 Integer
0 <= x_(40,_12) <= 1 Integer
0 <= x_(40,_13) <= 1 Integer
0 <= x_(40,_14) <= 1 Integer
0 <= x_(40,_15) <= 1 Integer
0 <= x_(40,_16) <= 1 Integer
0 <= x_(40,_17) <= 1 Integer
0 <= x_(40,_18) <= 1 Integer
0 <= x_(40,_19) <= 1 Integer
0 <= x_(40,_2) <= 1 Integer
0 <= x_(40,_20) <= 1 Integer
0 <= x_(40,_21) <= 1 Integer
0 <= x_(40,_22) <= 1 Integer
0 <= x_(40,_23) <= 1 Integer
0 <= x_(40,_24) <= 1 Integer
0 <= x_(40,_25) <= 1 Integer
0 <= x_(40,_26) <= 1 Integer
0 <= x_(40,_27) <= 1 Integer
0 <= x_(40,_28) <= 1 Integer
0 <= x_(40,_29) <= 1 Integer
0 <= x_(40,_3) <= 1 Integer
0 <= x_(40,_30) <= 1 Integer
0 <= x_(40,_31) <= 1 Integer
0 <= x_(40,_32) <= 1 Integer
0 <= x_(40,_33) <= 1 Integer
0 <= x_(40,_34) <= 1 Integer
0 <= x_(40,_35) <= 1 Integer
0 <= x_(40,_36) <= 1 Integer
0 <= x_(40,_37) <= 1 Integer
0 <= x_(40,_38) <= 1 Integer
0 <= x_(40,_39) <= 1 Integer
0 <= x_(40,_4) <= 1 Integer
0 <= x_(40,_41) <= 1 Integer
0 <= x_(40,_42) <= 1 Integer
0 <= x_(40,_43) <= 1 Integer
0 <= x_(40,_44) <= 1 Integer
0 <= x_(40,_45) <= 1 Integer
0 <= x_(40,_46) <= 1 Integer
0 <= x_(40,_47) <= 1 Integer
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0 <= x_(40,_49) <= 1 Integer
0 <= x_(40,_5) <= 1 Integer
0 <= x_(40,_6) <= 1 Integer
0 <= x_(40,_7) <= 1 Integer
0 <= x_(40,_8) <= 1 Integer
0 <= x_(40,_9) <= 1 Integer
```

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0 <= x_(41,_1) <= 1 Integer
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0 <= x_(41,_18) <= 1 Integer
0 <= x_(41,_19) <= 1 Integer
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0 <= x_(41,_34) <= 1 Integer
0 <= x_(41,_35) <= 1 Integer
0 <= x_(41,_36) <= 1 Integer
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0 <= x_(41,_38) <= 1 Integer
0 <= x_(41,_39) <= 1 Integer
0 <= x_(41,_4) <= 1 Integer
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0 <= x_(41,_43) <= 1 Integer
0 <= x_(41,_44) <= 1 Integer
0 <= x_(41,_45) <= 1 Integer
0 <= x_(41,_46) <= 1 Integer
0 <= x_(41,_47) <= 1 Integer
0 <= x_(41,_48) <= 1 Integer
0 <= x_(41,_49) <= 1 Integer
0 <= x_(41,_5) <= 1 Integer
0 <= x_(41,_6) <= 1 Integer
0 <= x_(41,_7) <= 1 Integer
```

```
0 <= x_(41,_8) <= 1 Integer
0 <= x_(41,_9) <= 1 Integer
0 <= x_(42,_0) <= 1 Integer
0 <= x_(42,_1) <= 1 Integer
0 <= x_(42,_10) <= 1 Integer
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0 <= x_(42,_14) <= 1 Integer
0 <= x_(42,_15) <= 1 Integer
0 <= x_(42,_16) <= 1 Integer
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0 <= x_(42,_18) <= 1 Integer
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0 <= x_(42,_2) <= 1 Integer
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0 <= x_(42,_27) <= 1 Integer
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0 <= x_(42,_29) <= 1 Integer
0 <= x_(42,_3) <= 1 Integer
0 <= x_(42,_30) <= 1 Integer
0 <= x_(42,_31) <= 1 Integer
0 <= x_(42,_32) <= 1 Integer
0 <= x_(42,_33) <= 1 Integer
0 <= x_(42,_34) <= 1 Integer
0 <= x_(42,_35) <= 1 Integer
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0 <= x_(42,_39) <= 1 Integer
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0 <= x_(42,_43) <= 1 Integer
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0 <= x_(42,_45) <= 1 Integer
0 <= x_(42,_46) <= 1 Integer
0 <= x_(42,_47) <= 1 Integer
0 <= x_(42,_48) <= 1 Integer
0 <= x_(42,_49) <= 1 Integer
0 <= x_(42,_5) <= 1 Integer
```

```
0 <= x_(42,_6) <= 1 Integer
0 <= x_(42,_7) <= 1 Integer
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0 <= x_(42,_9) <= 1 Integer
0 <= x_(43,_0) <= 1 Integer
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0 <= x_(43,_10) <= 1 Integer
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0 <= x_(43,_12) <= 1 Integer
0 <= x_(43,_13) <= 1 Integer
0 <= x_(43,_14) <= 1 Integer
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0 <= x_(43,_33) <= 1 Integer
0 <= x_(43,_34) <= 1 Integer
0 <= x_(43,_35) <= 1 Integer
0 <= x_(43,_36) <= 1 Integer
0 <= x_(43,_37) <= 1 Integer
0 <= x_(43,_38) <= 1 Integer
0 <= x_(43,_39) <= 1 Integer
0 <= x_(43,_4) <= 1 Integer
0 <= x_(43,_40) <= 1 Integer
0 <= x_(43,_41) <= 1 Integer
0 <= x_(43,_42) <= 1 Integer
0 <= x_(43,_44) <= 1 Integer
0 <= x_(43,_45) <= 1 Integer
0 <= x_(43,_46) <= 1 Integer
0 <= x_(43,_47) <= 1 Integer
0 <= x_(43,_48) <= 1 Integer
```

```
0 <= x_(43,_49) <= 1 Integer
0 <= x_(43,_5) <= 1 Integer
0 <= x_(43,_6) <= 1 Integer
0 <= x_(43,_7) <= 1 Integer
0 <= x_(43,_8) <= 1 Integer
0 <= x_(43,_9) <= 1 Integer
0 <= x_(44,_0) <= 1 Integer
0 <= x_(44,_1) <= 1 Integer
0 <= x_(44,_10) <= 1 Integer
0 <= x_(44,_11) <= 1 Integer
0 <= x_(44,_12) <= 1 Integer
0 <= x_(44,_13) <= 1 Integer
0 <= x_(44,_14) <= 1 Integer
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0 <= x_(44,_18) <= 1 Integer
0 <= x_(44,_19) <= 1 Integer
0 <= x_(44,_2) <= 1 Integer
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0 <= x_(44,_21) <= 1 Integer
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0 <= x_(44,_24) <= 1 Integer
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0 <= x_(44,_26) <= 1 Integer
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0 <= x_(44,_3) <= 1 Integer
0 <= x_(44,_30) <= 1 Integer
0 <= x_(44,_31) <= 1 Integer
0 <= x_(44,_32) <= 1 Integer
0 <= x_(44,_33) <= 1 Integer
0 <= x_(44,_34) <= 1 Integer
0 <= x_(44,_35) <= 1 Integer
0 <= x_(44,_36) <= 1 Integer
0 <= x_(44,_37) <= 1 Integer
0 <= x_(44,_38) <= 1 Integer
0 <= x_(44,_39) <= 1 Integer
0 <= x_(44,_4) <= 1 Integer
0 <= x_(44,_40) <= 1 Integer
0 <= x_(44,_41) <= 1 Integer
0 <= x_(44,_42) <= 1 Integer
0 <= x_(44,_43) <= 1 Integer
0 <= x_(44,_45) <= 1 Integer
0 <= x_(44,_46) <= 1 Integer
```

```
0 <= x_(44,_47) <= 1 Integer
0 <= x_(44,_48) <= 1 Integer
0 <= x_(44,_49) <= 1 Integer
0 <= x_(44,_5) <= 1 Integer
0 <= x_(44,_6) <= 1 Integer
0 <= x_(44,_7) <= 1 Integer
0 <= x_(44,_8) <= 1 Integer
0 <= x_(44,_9) <= 1 Integer
0 <= x_(45,_0) <= 1 Integer
0 <= x_(45,_1) <= 1 Integer
0 <= x_(45,_10) <= 1 Integer
0 <= x_(45,_11) <= 1 Integer
0 <= x_(45,_12) <= 1 Integer
0 <= x_(45,_13) <= 1 Integer
0 <= x_(45,_14) <= 1 Integer
0 <= x_(45,_15) <= 1 Integer
0 <= x_(45,_16) <= 1 Integer
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0 <= x_(45,_27) <= 1 Integer
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0 <= x_(45,_29) <= 1 Integer
0 <= x_(45,_3) <= 1 Integer
0 <= x_(45,_30) <= 1 Integer
0 <= x_(45,_31) <= 1 Integer
0 <= x_(45,_32) <= 1 Integer
0 <= x_(45,_33) <= 1 Integer
0 <= x_(45,_34) <= 1 Integer
0 <= x_(45,_35) <= 1 Integer
0 <= x_(45,_36) <= 1 Integer
0 <= x_(45,_37) <= 1 Integer
0 <= x_(45,_38) <= 1 Integer
0 <= x_(45,_39) <= 1 Integer
0 <= x_(45,_4) <= 1 Integer
0 <= x_(45,_40) <= 1 Integer
0 <= x_(45,_41) <= 1 Integer
0 <= x_(45,_42) <= 1 Integer
0 <= x_(45,_43) <= 1 Integer
```

```
0 <= x_(45,_44) <= 1 Integer
0 <= x_(45,_46) <= 1 Integer
0 <= x_(45,_47) <= 1 Integer
0 <= x_(45,_48) <= 1 Integer
0 <= x_(45,_49) <= 1 Integer
0 <= x_(45,_5) <= 1 Integer
0 <= x_(45,_6) <= 1 Integer
0 <= x_(45,_7) <= 1 Integer
0 <= x_(45,_8) <= 1 Integer
0 <= x_(45,_9) <= 1 Integer
0 <= x_(46,_0) <= 1 Integer
0 <= x_(46,_1) <= 1 Integer
0 <= x_(46,_10) <= 1 Integer
0 <= x_(46,_11) <= 1 Integer
0 <= x_(46,_12) <= 1 Integer
0 <= x_(46,_13) <= 1 Integer
0 <= x_(46,_14) <= 1 Integer
0 <= x_(46,_15) <= 1 Integer
0 <= x_(46,_16) <= 1 Integer
0 <= x_(46,_17) <= 1 Integer
0 <= x_(46,_18) <= 1 Integer
0 <= x_(46,_19) <= 1 Integer
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0 <= x_(46,_20) <= 1 Integer
0 <= x_(46,_21) <= 1 Integer
0 <= x_(46,_22) <= 1 Integer
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0 <= x_(46,_26) <= 1 Integer
0 <= x_(46,_27) <= 1 Integer
0 <= x_(46,_28) <= 1 Integer
0 <= x_(46,_29) <= 1 Integer
0 <= x_(46,_3) <= 1 Integer
0 <= x_(46,_30) <= 1 Integer
0 <= x_(46,_31) <= 1 Integer
0 <= x_(46,_32) <= 1 Integer
0 <= x_(46,_33) <= 1 Integer
0 <= x_(46,_34) <= 1 Integer
0 <= x_(46,_35) <= 1 Integer
0 <= x_(46,_36) <= 1 Integer
0 <= x_(46,_37) <= 1 Integer
0 <= x_(46,_38) <= 1 Integer
0 <= x_(46,_39) <= 1 Integer
0 <= x_(46,_4) <= 1 Integer
0 <= x_(46,_40) <= 1 Integer
0 <= x_(46,_41) <= 1 Integer
```

```
0 <= x_(46,_42) <= 1 Integer
0 <= x_(46,_43) <= 1 Integer
0 <= x_(46,_44) <= 1 Integer
0 <= x_(46,_45) <= 1 Integer
0 <= x_(46,_47) <= 1 Integer
0 <= x_(46,_48) <= 1 Integer
0 <= x_(46,_49) <= 1 Integer
0 <= x_(46,_5) <= 1 Integer
0 <= x_(46,_6) <= 1 Integer
0 <= x_(46,_7) <= 1 Integer
0 <= x_(46,_8) <= 1 Integer
0 <= x_(46,_9) <= 1 Integer
0 <= x_(47,_0) <= 1 Integer
0 <= x_(47,_1) <= 1 Integer
0 <= x_(47,_10) <= 1 Integer
0 <= x_(47,_11) <= 1 Integer
0 <= x_(47,_12) <= 1 Integer
0 <= x_(47,_13) <= 1 Integer
0 <= x_(47,_14) <= 1 Integer
0 <= x_(47,_15) <= 1 Integer
0 <= x_(47,_16) <= 1 Integer
0 <= x_(47,_17) <= 1 Integer
0 <= x_(47,_18) <= 1 Integer
0 <= x_(47,_19) <= 1 Integer
0 <= x_(47,_2) <= 1 Integer
0 <= x_(47,_20) <= 1 Integer
0 <= x_(47,_21) <= 1 Integer
0 <= x_(47,_22) <= 1 Integer
0 <= x_(47,_23) <= 1 Integer
0 <= x_(47,_24) <= 1 Integer
0 <= x_(47,_25) <= 1 Integer
0 <= x_(47,_26) <= 1 Integer
0 <= x_(47,_27) <= 1 Integer
0 <= x_(47,_28) <= 1 Integer
0 <= x_(47,_29) <= 1 Integer
0 <= x_(47,_3) <= 1 Integer
0 <= x_(47,_30) <= 1 Integer
0 <= x_(47,_31) <= 1 Integer
0 <= x_(47,_32) <= 1 Integer
0 <= x_(47,_33) <= 1 Integer
0 <= x_(47,_34) <= 1 Integer
0 <= x_(47,_35) <= 1 Integer
0 <= x_(47,_36) <= 1 Integer
0 <= x_(47,_37) <= 1 Integer
0 <= x_(47,_38) <= 1 Integer
0 <= x_(47,_39) <= 1 Integer
0 <= x_(47,_4) <= 1 Integer
```

```
0 <= x_(47,_40) <= 1 Integer
0 <= x_(47,_41) <= 1 Integer
0 <= x_(47,_42) <= 1 Integer
0 <= x_(47,_43) <= 1 Integer
0 <= x_(47,_44) <= 1 Integer
0 <= x_(47,_45) <= 1 Integer
0 <= x_(47,_46) <= 1 Integer
0 <= x_(47,_48) <= 1 Integer
0 <= x_(47,_49) <= 1 Integer
0 <= x_(47,_5) <= 1 Integer
0 <= x_(47,_6) <= 1 Integer
0 <= x_(47,_7) <= 1 Integer
0 <= x_(47,_8) <= 1 Integer
0 <= x_(47,_9) <= 1 Integer
0 <= x_(48,_0) <= 1 Integer
0 <= x_(48,_1) <= 1 Integer
0 <= x_(48,_10) <= 1 Integer
0 <= x_(48,_11) <= 1 Integer
0 <= x_(48,_12) <= 1 Integer
0 <= x_(48,_13) <= 1 Integer
0 <= x_(48,_14) <= 1 Integer
0 <= x_(48,_15) <= 1 Integer
0 <= x_(48,_16) <= 1 Integer
0 <= x_(48,_17) <= 1 Integer
0 <= x_(48,_18) <= 1 Integer
0 <= x_(48,_19) <= 1 Integer
0 <= x_(48,_2) <= 1 Integer
0 <= x_(48,_20) <= 1 Integer
0 <= x_(48,_21) <= 1 Integer
0 <= x_(48,_22) <= 1 Integer
0 <= x_(48,_23) <= 1 Integer
0 <= x_(48,_24) <= 1 Integer
0 <= x_(48,_25) <= 1 Integer
0 <= x_(48,_26) <= 1 Integer
0 <= x_(48,_27) <= 1 Integer
0 <= x_(48,_28) <= 1 Integer
0 <= x_(48,_29) <= 1 Integer
0 <= x_(48,_3) <= 1 Integer
0 <= x_(48,_30) <= 1 Integer
0 <= x_(48,_31) <= 1 Integer
0 <= x_(48,_32) <= 1 Integer
0 <= x_(48,_33) <= 1 Integer
0 <= x_(48,_34) <= 1 Integer
0 <= x_(48,_35) <= 1 Integer
0 <= x_(48,_36) <= 1 Integer
0 <= x_(48,_37) <= 1 Integer
0 <= x_(48,_38) <= 1 Integer
```

```
0 <= x_(48,_39) <= 1 Integer
0 <= x_(48,_4) <= 1 Integer
0 <= x_(48,_40) <= 1 Integer
0 <= x_(48,_41) <= 1 Integer
0 <= x_(48,_42) <= 1 Integer
0 <= x_(48,_43) <= 1 Integer
0 <= x_(48,_44) <= 1 Integer
0 <= x_(48,_45) <= 1 Integer
0 <= x_(48,_46) <= 1 Integer
0 <= x_(48,_47) <= 1 Integer
0 <= x_(48,_49) <= 1 Integer
0 <= x_(48,_5) <= 1 Integer
0 <= x_(48,_6) <= 1 Integer
0 <= x_(48,_7) <= 1 Integer
0 <= x_(48,_8) <= 1 Integer
0 <= x_(48,_9) <= 1 Integer
0 <= x_(49,_0) <= 1 Integer
0 <= x_(49,_1) <= 1 Integer
0 <= x_(49,_10) <= 1 Integer
0 <= x_(49,_11) <= 1 Integer
0 <= x_(49,_12) <= 1 Integer
0 <= x_(49,_13) <= 1 Integer
0 <= x_(49,_14) <= 1 Integer
0 <= x_(49,_15) <= 1 Integer
0 <= x_(49,_16) <= 1 Integer
0 <= x_(49,_17) <= 1 Integer
0 <= x_(49,_18) <= 1 Integer
0 <= x_(49,_19) <= 1 Integer
0 <= x_(49,_2) <= 1 Integer
0 <= x_(49,_20) <= 1 Integer
0 <= x_(49,_21) <= 1 Integer
0 <= x_(49,_22) <= 1 Integer
0 <= x_(49,_23) <= 1 Integer
0 <= x_(49,_24) <= 1 Integer
0 <= x_(49,_25) <= 1 Integer
0 <= x_(49,_26) <= 1 Integer
0 <= x_(49,_27) <= 1 Integer
0 <= x_(49,_28) <= 1 Integer
0 <= x_(49,_29) <= 1 Integer
0 <= x_(49,_3) <= 1 Integer
0 <= x_(49,_30) <= 1 Integer
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0 <= x_(49,_32) <= 1 Integer
0 <= x_(49,_33) <= 1 Integer
0 <= x_(49,_34) <= 1 Integer
0 <= x_(49,_35) <= 1 Integer
0 <= x_(49,_36) <= 1 Integer
```

```
0 <= x_(49,_37) <= 1 Integer
0 <= x_(49,_38) <= 1 Integer
0 <= x_(49,_39) <= 1 Integer
0 <= x_(49,_4) <= 1 Integer
0 <= x_(49,_40) <= 1 Integer
0 <= x_(49,_41) <= 1 Integer
0 <= x_(49,_42) <= 1 Integer
0 <= x_(49,_43) <= 1 Integer
0 <= x_(49,_44) <= 1 Integer
0 <= x_(49,_45) <= 1 Integer
0 <= x_(49,_46) <= 1 Integer
0 <= x_(49,_47) <= 1 Integer
0 <= x_(49,_48) <= 1 Integer
0 <= x_(49,_5) <= 1 Integer
0 <= x_(49,_6) <= 1 Integer
0 <= x_(49,_7) <= 1 Integer
0 <= x_(49,_8) <= 1 Integer
0 <= x_(49,_9) <= 1 Integer
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0 <= x_(5,_10) <= 1 Integer
0 <= x_(5,_11) <= 1 Integer
0 <= x_(5,_12) <= 1 Integer
0 <= x_(5,_13) <= 1 Integer
0 <= x_(5,_14) <= 1 Integer
0 <= x_(5,_15) <= 1 Integer
0 <= x_(5,_16) <= 1 Integer
0 <= x_(5,_17) <= 1 Integer
0 <= x_(5,_18) <= 1 Integer
0 <= x_(5,_19) <= 1 Integer
0 <= x_(5,_2) <= 1 Integer
0 <= x_(5,_20) <= 1 Integer
0 <= x_(5,_21) <= 1 Integer
0 <= x_(5,_22) <= 1 Integer
0 <= x_(5,_23) <= 1 Integer
0 <= x_(5,_24) <= 1 Integer
0 <= x_(5,_25) <= 1 Integer
0 <= x_(5,_26) <= 1 Integer
0 <= x_(5,_27) <= 1 Integer
0 <= x_(5,_28) <= 1 Integer
0 <= x_(5,_29) <= 1 Integer
0 <= x_(5,_3) <= 1 Integer
0 <= x_(5,_30) <= 1 Integer
0 <= x_(5,_31) <= 1 Integer
0 <= x_(5,_32) <= 1 Integer
0 <= x_(5,_33) <= 1 Integer
0 <= x_(5,_34) <= 1 Integer
```

```
0 <= x_(5,_35) <= 1 Integer
0 <= x_(5,_36) <= 1 Integer
0 <= x_(5,_37) <= 1 Integer
0 <= x_(5,_38) <= 1 Integer
0 <= x_(5,_39) <= 1 Integer
0 <= x_(5,_4) <= 1 Integer
0 <= x_(5,_40) <= 1 Integer
0 <= x_(5,_41) <= 1 Integer
0 <= x_(5,_42) <= 1 Integer
0 <= x_(5,_43) <= 1 Integer
0 <= x_(5,_44) <= 1 Integer
0 <= x_(5,_45) <= 1 Integer
0 <= x_(5,_46) <= 1 Integer
0 <= x_(5,_47) <= 1 Integer
0 <= x_(5,_48) <= 1 Integer
0 <= x_(5,_49) <= 1 Integer
0 <= x_(5,_6) <= 1 Integer
0 <= x_(5,_7) <= 1 Integer
0 <= x_(5,_8) <= 1 Integer
0 <= x_(5,_9) <= 1 Integer
0 <= x_(6,_0) <= 1 Integer
0 <= x_(6,_1) <= 1 Integer
0 <= x_(6,_10) <= 1 Integer
0 <= x_(6,_11) <= 1 Integer
0 <= x_(6,_12) <= 1 Integer
0 <= x_(6,_13) <= 1 Integer
0 <= x_(6,_14) <= 1 Integer
0 <= x_(6,_15) <= 1 Integer
0 <= x_(6,_16) <= 1 Integer
0 <= x_(6,_17) <= 1 Integer
0 <= x_(6,_18) <= 1 Integer
0 <= x_(6,_19) <= 1 Integer
0 <= x_(6,_2) <= 1 Integer
0 <= x_(6,_20) <= 1 Integer
0 <= x_(6,_21) <= 1 Integer
0 <= x_(6,_22) <= 1 Integer
0 <= x_(6,_23) <= 1 Integer
0 <= x_(6,_24) <= 1 Integer
0 <= x_(6,_25) <= 1 Integer
0 <= x_(6,_26) <= 1 Integer
0 <= x_(6,_27) <= 1 Integer
0 <= x_(6,_28) <= 1 Integer
0 <= x_(6,_29) <= 1 Integer
0 <= x_(6,_3) <= 1 Integer
0 <= x_(6,_30) <= 1 Integer
0 <= x_(6,_31) <= 1 Integer
0 <= x_(6,_32) <= 1 Integer
```

```
0 <= x_(6,_33) <= 1 Integer
0 <= x_(6,_34) <= 1 Integer
0 <= x_(6,_35) <= 1 Integer
0 <= x_(6,_36) <= 1 Integer
0 <= x_(6,_37) <= 1 Integer
0 <= x_(6,_38) <= 1 Integer
0 <= x_(6,_39) <= 1 Integer
0 <= x_(6,_4) <= 1 Integer
0 <= x_(6,_40) <= 1 Integer
0 <= x_(6,_41) <= 1 Integer
0 <= x_(6,_42) <= 1 Integer
0 <= x_(6,_43) <= 1 Integer
0 <= x_(6,_44) <= 1 Integer
0 <= x_(6,_45) <= 1 Integer
0 <= x_(6,_46) <= 1 Integer
0 <= x_(6,_47) <= 1 Integer
0 <= x_(6,_48) <= 1 Integer
0 <= x_(6,_49) <= 1 Integer
0 <= x_(6,_5) <= 1 Integer
0 <= x_(6,_7) <= 1 Integer
0 <= x_(6,_8) <= 1 Integer
0 <= x_(6,_9) <= 1 Integer
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0 <= x_(7,_1) <= 1 Integer
0 <= x_(7,_10) <= 1 Integer
0 <= x_(7,_11) <= 1 Integer
0 <= x_(7,_12) <= 1 Integer
0 <= x_(7,_13) <= 1 Integer
0 <= x_(7,_14) <= 1 Integer
0 <= x_(7,_15) <= 1 Integer
0 <= x_(7,_16) <= 1 Integer
0 <= x_(7,_17) <= 1 Integer
0 <= x_(7,_18) <= 1 Integer
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0 <= x_(7,_2) <= 1 Integer
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0 <= x_(7,_21) <= 1 Integer
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0 <= x_(7,_23) <= 1 Integer
0 <= x_(7,_24) <= 1 Integer
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0 <= x_(7,_28) <= 1 Integer
0 <= x_(7,_29) <= 1 Integer
0 <= x_(7,_3) <= 1 Integer
0 <= x_(7,_30) <= 1 Integer
```

```
0 <= x_(7,_31) <= 1 Integer
0 <= x_(7,_32) <= 1 Integer
0 <= x_(7,_33) <= 1 Integer
0 <= x_(7,_34) <= 1 Integer
0 <= x_(7,_35) <= 1 Integer
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0 <= x_(7,_37) <= 1 Integer
0 <= x_(7,_38) <= 1 Integer
0 <= x_(7,_39) <= 1 Integer
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0 <= x_(7,_40) <= 1 Integer
0 <= x_(7,_41) <= 1 Integer
0 <= x_(7,_42) <= 1 Integer
0 <= x_(7,_43) <= 1 Integer
0 <= x_(7,_44) <= 1 Integer
0 <= x_(7,_45) <= 1 Integer
0 <= x_(7,_46) <= 1 Integer
0 <= x_(7,_47) <= 1 Integer
0 <= x_(7,_48) <= 1 Integer
0 <= x_(7,_49) <= 1 Integer
0 <= x_(7,_5) <= 1 Integer
0 <= x_(7,_6) <= 1 Integer
0 <= x_(7,_8) <= 1 Integer
0 <= x_(7,_9) <= 1 Integer
0 <= x_(8,_0) <= 1 Integer
0 <= x_(8,_1) <= 1 Integer
0 <= x_(8,_10) <= 1 Integer
0 <= x_(8,_11) <= 1 Integer
0 <= x_(8,_12) <= 1 Integer
0 <= x_(8,_13) <= 1 Integer
0 <= x_(8,_14) <= 1 Integer
0 <= x_(8,_15) <= 1 Integer
0 <= x_(8,_16) <= 1 Integer
0 <= x_(8,_17) <= 1 Integer
0 <= x_(8,_18) <= 1 Integer
0 <= x_(8,_19) <= 1 Integer
0 <= x_(8,_2) <= 1 Integer
0 <= x_(8,_20) <= 1 Integer
0 <= x_(8,_21) <= 1 Integer
0 <= x_(8,_22) <= 1 Integer
0 <= x_(8,_23) <= 1 Integer
0 <= x_(8,_24) <= 1 Integer
0 <= x_(8,_25) <= 1 Integer
0 <= x_(8,_26) <= 1 Integer
0 <= x_(8,_27) <= 1 Integer
0 <= x_(8,_28) <= 1 Integer
0 <= x_(8,_29) <= 1 Integer
```

```
0 <= x_(8,_3) <= 1 Integer
0 <= x_(8,_30) <= 1 Integer
0 <= x_(8,_31) <= 1 Integer
0 <= x_(8,_32) <= 1 Integer
0 <= x_(8,_33) <= 1 Integer
0 <= x_(8,_34) <= 1 Integer
0 <= x_(8,_35) <= 1 Integer
0 <= x_(8,_36) <= 1 Integer
0 <= x_(8,_37) <= 1 Integer
0 <= x_(8,_38) <= 1 Integer
0 <= x_(8,_39) <= 1 Integer
0 <= x_(8,_4) <= 1 Integer
0 <= x_(8,_40) <= 1 Integer
0 <= x_(8,_41) <= 1 Integer
0 <= x_(8,_42) <= 1 Integer
0 <= x_(8,_43) <= 1 Integer
0 <= x_(8,_44) <= 1 Integer
0 <= x_(8,_45) <= 1 Integer
0 <= x_(8,_46) <= 1 Integer
0 <= x_(8,_47) <= 1 Integer
0 <= x_(8,_48) <= 1 Integer
0 <= x_(8,_49) <= 1 Integer
0 <= x_(8,_5) <= 1 Integer
0 <= x_(8,_6) <= 1 Integer
0 <= x_(8,_7) <= 1 Integer
0 <= x_(8,_9) <= 1 Integer
0 <= x_(9,_0) <= 1 Integer
0 <= x_(9,_1) <= 1 Integer
0 <= x_(9,_10) <= 1 Integer
0 <= x_(9,_11) <= 1 Integer
0 <= x_(9,_12) <= 1 Integer
0 <= x_(9,_13) <= 1 Integer
0 <= x_(9,_14) <= 1 Integer
0 <= x_(9,_15) <= 1 Integer
0 <= x_(9,_16) <= 1 Integer
0 <= x_(9,_17) <= 1 Integer
0 <= x_(9,_18) <= 1 Integer
0 <= x_(9,_19) <= 1 Integer
0 <= x_(9,_2) <= 1 Integer
0 <= x_(9,_20) <= 1 Integer
0 <= x_(9,_21) <= 1 Integer
0 <= x_(9,_22) <= 1 Integer
0 <= x_(9,_23) <= 1 Integer
0 <= x_(9,_24) <= 1 Integer
0 <= x_(9,_25) <= 1 Integer
0 <= x_(9,_26) <= 1 Integer
0 <= x_(9,_27) <= 1 Integer
```

```
0 <= x_(9,_28) <= 1 Integer
0 <= x_(9,_29) <= 1 Integer
0 <= x_(9,_3) <= 1 Integer
0 <= x_(9,_30) <= 1 Integer
0 <= x_(9,_31) <= 1 Integer
0 <= x_(9,_32) <= 1 Integer
0 <= x_(9,_33) <= 1 Integer
0 <= x_(9,_34) <= 1 Integer
0 <= x_(9,_35) <= 1 Integer
0 <= x_(9,_36) <= 1 Integer
0 <= x_(9,_37) <= 1 Integer
0 <= x_(9,_38) <= 1 Integer
0 <= x_(9,_39) <= 1 Integer
0 <= x_(9,_4) <= 1 Integer
0 <= x_(9,_40) <= 1 Integer
0 <= x_(9,_41) <= 1 Integer
0 <= x_(9,_42) <= 1 Integer
0 <= x_(9,_43) <= 1 Integer
0 <= x_(9,_44) <= 1 Integer
0 <= x_(9,_45) <= 1 Integer
0 <= x_(9,_46) <= 1 Integer
0 <= x_(9,_47) <= 1 Integer
0 <= x_(9,_48) <= 1 Integer
0 <= x_(9,_49) <= 1 Integer
0 <= x_(9,_5) <= 1 Integer
0 <= x_(9,_6) <= 1 Integer
0 <= x_(9,_7) <= 1 Integer
0 <= x_(9,_8) <= 1 Integer
```

[119]:
```python
#constraints
for k in sites:
    cap = 1 if k != 0 else K
    #inbound connection
    prob+= lpSum([ x[(i,k)] for i in sites if (i,k) in x]) ==cap
    #outbound connection
    prob+=lpSum([ x[(k,i)] for i in sites if (k,i) in x]) ==cap

#subtour elimination
N=len(sites)/K
for i in sites:
    for j in sites:
        if i != j and (i != 0 and j!= 0) and (i,j) in x:
            prob += u[i] - u[j] <= (N)*(1-x[(i,j)]) - 1
```

[120]:
```python
%time prob.solve()
#prob.solve(GLPK_CMD(options=['--simplex']))
print(LpStatus[prob.status])
```

```
Welcome to the CBC MILP Solver
Version: 2.10.3
Build Date: Dec 15 2019

command line - /home/sahil/.local/lib/python3.10/site-
packages/pulp/solverdir/cbc/linux/64/cbc /tmp/1f7b2626bed34952a3011cac70ea61cd-
pulp.mps timeMode elapsed branch printingOptions all solution
/tmp/1f7b2626bed34952a3011cac70ea61cd-pulp.sol (default strategy 1)
At line 2 NAME          MODEL
At line 3 ROWS
At line 2457 COLUMNS
At line 21862 RHS
At line 24315 BOUNDS
At line 26815 ENDATA
Problem MODEL has 2452 rows, 2499 columns and 11956 elements
Coin0008I MODEL read with 0 errors
Option for timeMode changed from cpu to elapsed
Continuous objective value is 771.341 - 0.01 seconds
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0003I 0 fixed, 0 tightened bounds, 2352 strengthened rows, 0 substitutions
Cgl0004I processed model has 2452 rows, 2499 columns (2499 integer (2450 of
which binary)) and 33124 elements
Cbc0038I Initial state - 105 integers unsatisfied sum - 3.08163
Cbc0038I Pass   1: suminf.    2.78000 (81) obj. 827.718 iterations 822
Cbc0038I Pass   2: suminf.    4.60000 (57) obj. 1777.29 iterations 428
Cbc0038I Pass   3: suminf.   11.08000 (58) obj. 1788.3 iterations 208
Cbc0038I Pass   4: suminf.    8.49333 (45) obj. 1998.72 iterations 391
Cbc0038I Pass   5: suminf.    9.58667 (52) obj. 1993.07 iterations 161
Cbc0038I Pass   6: suminf.    1.92000 (7) obj. 2132.89 iterations 268
Cbc0038I Pass   7: suminf.    1.92000 (9) obj. 2137.13 iterations 95
Cbc0038I Pass   8: suminf.    2.20000 (7) obj. 2157.17 iterations 104
Cbc0038I Pass   9: suminf.    1.92000 (10) obj. 2178.4 iterations 53
Cbc0038I Pass  10: suminf.    1.92000 (16) obj. 2186.12 iterations 192
Cbc0038I Pass  11: suminf.    2.40000 (8) obj. 2141.92 iterations 421
Cbc0038I Pass  12: suminf.    1.92000 (19) obj. 2148 iterations 171
Cbc0038I Pass  13: suminf.    8.50819 (28) obj. 2133.88 iterations 142
Cbc0038I Pass  14: suminf.    6.92000 (28) obj. 2109.76 iterations 218
Cbc0038I Pass  15: suminf.   10.14362 (32) obj. 2054.92 iterations 138
Cbc0038I Pass  16: suminf.    9.25333 (53) obj. 2034.78 iterations 111
Cbc0038I Pass  17: suminf.    2.40000 (6) obj. 2054.55 iterations 198
Cbc0038I Pass  18: suminf.    7.52000 (31) obj. 2093.32 iterations 156
```

```
Cbc0038I Pass  19: suminf.    7.92000 (27) obj. 2191.35 iterations 366
Cbc0038I Pass  20: suminf.    1.92000 (9) obj. 2158.91 iterations 118
Cbc0038I Pass  21: suminf.    3.42000 (17) obj. 2131.71 iterations 340
Cbc0038I Pass  22: suminf.    7.92000 (44) obj. 2133.16 iterations 135
Cbc0038I Pass  23: suminf.    4.70707 (14) obj. 2152.12 iterations 324
Cbc0038I Pass  24: suminf.    8.25333 (32) obj. 2158.2 iterations 166
Cbc0038I Pass  25: suminf.   13.32000 (30) obj. 2138.27 iterations 298
Cbc0038I Pass  26: suminf.    1.92000 (17) obj. 2162.52 iterations 166
Cbc0038I Pass  27: suminf.    2.52000 (6) obj. 2137.04 iterations 367
Cbc0038I Pass  28: suminf.    1.92000 (13) obj. 2146.19 iterations 177
Cbc0038I Pass  29: suminf.    6.49796 (54) obj. 2187.69 iterations 351
Cbc0038I Pass  30: suminf.    1.92000 (18) obj. 2158.33 iterations 81
Cbc0038I No solution found this major pass
Cbc0038I Before mini branch and bound, 2237 integers at bound fixed and 0
continuous
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2144 rows 220 columns -
too large
Cbc0038I Mini branch and bound did not improve solution (3.89 seconds)
Cbc0038I After 3.89 seconds - Feasibility pump exiting - took 0.67 seconds
Cbc0031I 45 added rows had average density of 144.86667
Cbc0013I At root node, 45 cuts changed objective from 771.41076 to 903.89028 in
14 passes
Cbc0014I Cut generator 0 (Probing) - 19 row cuts average 160.6 elements, 0
column cuts (0 active)  in 0.239 seconds - new frequency is -100
Cbc0014I Cut generator 1 (Gomory) - 191 row cuts average 473.1 elements, 0
column cuts (0 active)  in 0.130 seconds - new frequency is 1
Cbc0014I Cut generator 2 (Knapsack) - 3 row cuts average 2.0 elements, 0 column
cuts (0 active)  in 0.026 seconds - new frequency is -100
Cbc0014I Cut generator 3 (Clique) - 0 row cuts average 0.0 elements, 0 column
cuts (0 active)  in 0.002 seconds - new frequency is -100
Cbc0014I Cut generator 4 (MixedIntegerRounding2) - 28 row cuts average 272.6
elements, 0 column cuts (0 active)  in 0.035 seconds - new frequency is 1
Cbc0014I Cut generator 5 (FlowCover) - 0 row cuts average 0.0 elements, 0 column
cuts (0 active)  in 0.031 seconds - new frequency is -100
Cbc0014I Cut generator 6 (TwoMirCuts) - 267 row cuts average 166.8 elements, 0
column cuts (0 active)  in 0.064 seconds - new frequency is 1
Cbc0014I Cut generator 7 (ZeroHalf) - 51 row cuts average 3.7 elements, 0 column
cuts (0 active)  in 0.104 seconds - new frequency is 1
Cbc0010I After 0 nodes, 1 on tree, 1e+50 best solution, best possible 903.89028
(5.50 seconds)
Cbc0010I After 100 nodes, 57 on tree, 1e+50 best solution, best possible
903.89028 (8.09 seconds)
Cbc0004I Integer solution of 1298.4101 found after 8986 iterations and 126 nodes
(8.36 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2094 rows 105 columns -
14 fixed gives 1367, 55 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 269 rows 51 columns
Cbc0004I Integer solution of 999.68951 found after 12960 iterations and 182
```

```
nodes (9.63 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2167 rows 100 columns -
10 fixed gives 2020, 79 - still too large
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 534 rows 76 columns
Cbc0010I After 200 nodes, 74 on tree, 999.68951 best solution, best possible
903.89028 (10.13 seconds)
Cbc0004I Integer solution of 979.17069 found after 19476 iterations and 296
nodes (11.78 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 76 rows 33 columns
Cbc0010I After 300 nodes, 111 on tree, 979.17069 best solution, best possible
903.89028 (11.88 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 1853 rows 64 columns -
3 fixed gives 1811, 63 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 231 rows 50 columns
Cbc0010I After 400 nodes, 156 on tree, 979.17069 best solution, best possible
903.89028 (13.84 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 285 rows 68 columns
Cbc0010I After 500 nodes, 203 on tree, 979.17069 best solution, best possible
903.89028 (16.00 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 1947 rows 78 columns -
12 fixed gives 1718, 57 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 67 rows 24 columns
Cbc0010I After 600 nodes, 248 on tree, 979.17069 best solution, best possible
903.89028 (18.25 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 173 rows 42 columns
Cbc0010I After 700 nodes, 295 on tree, 979.17069 best solution, best possible
903.89028 (19.99 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 1848 rows 80 columns -
8 fixed gives 1755, 67 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 323 rows 56 columns
Cbc0010I After 800 nodes, 330 on tree, 979.17069 best solution, best possible
903.89028 (21.47 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 81 rows 41 columns
Cbc0010I After 900 nodes, 374 on tree, 979.17069 best solution, best possible
903.89028 (23.10 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 188 rows 56 columns
Cbc0010I After 1000 nodes, 409 on tree, 979.17069 best solution, best possible
903.89028 (24.73 seconds)
Cbc0010I After 1100 nodes, 475 on tree, 979.17069 best solution, best possible
903.89028 (26.35 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2049 rows 115 columns -
16 fixed gives 1796, 68 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 188 rows 52 columns
Cbc0010I After 1200 nodes, 485 on tree, 979.17069 best solution, best possible
903.89028 (27.53 seconds)
Cbc0010I After 1300 nodes, 491 on tree, 979.17069 best solution, best possible
903.89028 (28.94 seconds)
Cbc0010I After 1400 nodes, 489 on tree, 979.17069 best solution, best possible
```

```
903.89028 (29.95 seconds)
Cbc0010I After 1500 nodes, 470 on tree, 979.17069 best solution, best possible
903.89028 (31.02 seconds)
Cbc0010I After 1600 nodes, 483 on tree, 979.17069 best solution, best possible
903.89028 (32.35 seconds)
Cbc0010I After 1700 nodes, 488 on tree, 979.17069 best solution, best possible
903.89028 (33.43 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 1952 rows 70 columns -
10 fixed gives 1755, 52 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 102 rows 37 columns
Cbc0010I After 1800 nodes, 485 on tree, 979.17069 best solution, best possible
903.89028 (34.66 seconds)
Cbc0010I After 1900 nodes, 494 on tree, 979.17069 best solution, best possible
903.89028 (35.82 seconds)
Cbc0010I After 2000 nodes, 477 on tree, 979.17069 best solution, best possible
903.89028 (36.84 seconds)
Cbc0010I After 2100 nodes, 472 on tree, 979.17069 best solution, best possible
903.89028 (38.15 seconds)
Cbc0010I After 2200 nodes, 475 on tree, 979.17069 best solution, best possible
903.89028 (39.50 seconds)
Cbc0010I After 2300 nodes, 472 on tree, 979.17069 best solution, best possible
903.89028 (40.74 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2067 rows 108 columns -
13 fixed gives 1766, 60 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 134 rows 45 columns
Cbc0010I After 2400 nodes, 467 on tree, 979.17069 best solution, best possible
903.89028 (42.13 seconds)
Cbc0010I After 2500 nodes, 469 on tree, 979.17069 best solution, best possible
903.89028 (43.60 seconds)
Cbc0010I After 2600 nodes, 474 on tree, 979.17069 best solution, best possible
903.89028 (44.95 seconds)
Cbc0010I After 2700 nodes, 473 on tree, 979.17069 best solution, best possible
903.89028 (46.15 seconds)
Cbc0010I After 2800 nodes, 467 on tree, 979.17069 best solution, best possible
903.89028 (47.51 seconds)
Cbc0010I After 2900 nodes, 473 on tree, 979.17069 best solution, best possible
903.89028 (49.07 seconds)
Cbc0010I After 3000 nodes, 472 on tree, 979.17069 best solution, best possible
903.89028 (50.49 seconds)
Cbc0010I After 3100 nodes, 473 on tree, 979.17069 best solution, best possible
903.89028 (52.13 seconds)
Cbc0010I After 3200 nodes, 472 on tree, 979.17069 best solution, best possible
903.89028 (53.54 seconds)
Cbc0010I After 3300 nodes, 469 on tree, 979.17069 best solution, best possible
903.89028 (54.87 seconds)
Cbc0010I After 3400 nodes, 465 on tree, 979.17069 best solution, best possible
903.89028 (56.13 seconds)
Cbc0010I After 3500 nodes, 471 on tree, 979.17069 best solution, best possible
```

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903.89028 (57.37 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2063 rows 107 columns -
14 fixed gives 1810, 60 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 199 rows 47 columns
Cbc0010I After 3600 nodes, 469 on tree, 979.17069 best solution, best possible
903.89028 (58.61 seconds)
Cbc0010I After 3700 nodes, 463 on tree, 979.17069 best solution, best possible
903.89028 (60.04 seconds)
Cbc0010I After 3800 nodes, 464 on tree, 979.17069 best solution, best possible
903.89028 (61.47 seconds)
Cbc0010I After 3900 nodes, 471 on tree, 979.17069 best solution, best possible
903.89028 (62.90 seconds)
Cbc0010I After 4000 nodes, 480 on tree, 979.17069 best solution, best possible
903.89028 (64.09 seconds)
Cbc0010I After 4100 nodes, 467 on tree, 979.17069 best solution, best possible
903.89028 (65.36 seconds)
Cbc0010I After 4200 nodes, 468 on tree, 979.17069 best solution, best possible
903.89028 (66.59 seconds)
Cbc0010I After 4300 nodes, 466 on tree, 979.17069 best solution, best possible
903.89028 (67.85 seconds)
Cbc0010I After 4400 nodes, 466 on tree, 979.17069 best solution, best possible
903.89028 (69.20 seconds)
Cbc0010I After 4500 nodes, 466 on tree, 979.17069 best solution, best possible
903.89028 (70.52 seconds)
Cbc0010I After 4600 nodes, 461 on tree, 979.17069 best solution, best possible
903.89028 (71.93 seconds)
Cbc0010I After 4700 nodes, 465 on tree, 979.17069 best solution, best possible
903.89028 (73.34 seconds)
Cbc0010I After 4800 nodes, 466 on tree, 979.17069 best solution, best possible
903.89028 (74.63 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 468 rows 67 columns
Cbc0010I After 4900 nodes, 461 on tree, 979.17069 best solution, best possible
903.89028 (75.70 seconds)
Cbc0010I After 5000 nodes, 465 on tree, 979.17069 best solution, best possible
903.89028 (77.14 seconds)
Cbc0010I After 5100 nodes, 544 on tree, 979.17069 best solution, best possible
903.89028 (78.67 seconds)
Cbc0010I After 5200 nodes, 557 on tree, 979.17069 best solution, best possible
903.89028 (79.72 seconds)
Cbc0010I After 5300 nodes, 539 on tree, 979.17069 best solution, best possible
903.89028 (80.96 seconds)
Cbc0010I After 5400 nodes, 533 on tree, 979.17069 best solution, best possible
903.89028 (82.09 seconds)
Cbc0010I After 5500 nodes, 527 on tree, 979.17069 best solution, best possible
903.89028 (83.42 seconds)
Cbc0010I After 5600 nodes, 523 on tree, 979.17069 best solution, best possible
903.89028 (84.59 seconds)
Cbc0010I After 5700 nodes, 555 on tree, 979.17069 best solution, best possible
```

```
903.89028 (85.95 seconds)
Cbc0010I After 5800 nodes, 551 on tree, 979.17069 best solution, best possible
903.89028 (87.05 seconds)
Cbc0010I After 5900 nodes, 541 on tree, 979.17069 best solution, best possible
903.89028 (88.22 seconds)
Cbc0010I After 6000 nodes, 541 on tree, 979.17069 best solution, best possible
903.89028 (89.38 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 974 rows 85 columns
Cbc0010I After 6100 nodes, 534 on tree, 979.17069 best solution, best possible
903.89028 (90.47 seconds)
Cbc0010I After 6200 nodes, 530 on tree, 979.17069 best solution, best possible
903.89028 (91.58 seconds)
Cbc0010I After 6300 nodes, 531 on tree, 979.17069 best solution, best possible
903.89028 (92.75 seconds)
Cbc0010I After 6400 nodes, 527 on tree, 979.17069 best solution, best possible
903.89028 (93.90 seconds)
Cbc0010I After 6500 nodes, 527 on tree, 979.17069 best solution, best possible
903.89028 (95.10 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2180 rows 113 columns -
17 fixed gives 1832, 62 - still too large
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 192 rows 60 columns
Cbc0010I After 6600 nodes, 520 on tree, 979.17069 best solution, best possible
903.89028 (96.39 seconds)
Cbc0010I After 6700 nodes, 530 on tree, 979.17069 best solution, best possible
903.89028 (97.58 seconds)
Cbc0010I After 6800 nodes, 529 on tree, 979.17069 best solution, best possible
903.89028 (98.76 seconds)
Cbc0010I After 6900 nodes, 524 on tree, 979.17069 best solution, best possible
903.89028 (99.91 seconds)
Cbc0010I After 7000 nodes, 529 on tree, 979.17069 best solution, best possible
903.89028 (100.99 seconds)
Cbc0010I After 7100 nodes, 521 on tree, 979.17069 best solution, best possible
903.89028 (102.18 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2113 rows 88 columns -
14 fixed gives 1955, 62 - still too large
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 141 rows 57 columns
Cbc0010I After 7200 nodes, 528 on tree, 979.17069 best solution, best possible
903.89028 (103.52 seconds)
Cbc0010I After 7300 nodes, 515 on tree, 979.17069 best solution, best possible
903.89028 (104.75 seconds)
Cbc0010I After 7400 nodes, 521 on tree, 979.17069 best solution, best possible
903.89028 (106.11 seconds)
Cbc0010I After 7500 nodes, 531 on tree, 979.17069 best solution, best possible
903.89028 (107.50 seconds)
Cbc0010I After 7600 nodes, 520 on tree, 979.17069 best solution, best possible
903.89028 (108.59 seconds)
Cbc0010I After 7700 nodes, 521 on tree, 979.17069 best solution, best possible
903.89028 (109.77 seconds)
```

```
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2118 rows 91 columns -
15 fixed gives 1742, 57 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 140 rows 39 columns
Cbc0010I After 7800 nodes, 518 on tree, 979.17069 best solution, best possible
903.89028 (111.04 seconds)
Cbc0010I After 7900 nodes, 511 on tree, 979.17069 best solution, best possible
903.89028 (112.20 seconds)
Cbc0010I After 8000 nodes, 531 on tree, 979.17069 best solution, best possible
903.89028 (113.43 seconds)
Cbc0010I After 8100 nodes, 537 on tree, 979.17069 best solution, best possible
903.89028 (114.67 seconds)
Cbc0010I After 8200 nodes, 522 on tree, 979.17069 best solution, best possible
903.89028 (115.82 seconds)
Cbc0010I After 8300 nodes, 522 on tree, 979.17069 best solution, best possible
903.89028 (116.93 seconds)
Cbc0010I After 8400 nodes, 523 on tree, 979.17069 best solution, best possible
903.89028 (118.07 seconds)
Cbc0010I After 8500 nodes, 525 on tree, 979.17069 best solution, best possible
903.89028 (119.29 seconds)
Cbc0010I After 8600 nodes, 524 on tree, 979.17069 best solution, best possible
903.89028 (120.50 seconds)
Cbc0010I After 8700 nodes, 522 on tree, 979.17069 best solution, best possible
903.89028 (121.81 seconds)
Cbc0010I After 8800 nodes, 541 on tree, 979.17069 best solution, best possible
903.89028 (123.15 seconds)
Cbc0010I After 8900 nodes, 539 on tree, 979.17069 best solution, best possible
903.89028 (124.39 seconds)
Cbc0010I After 9000 nodes, 551 on tree, 979.17069 best solution, best possible
903.89028 (125.53 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2122 rows 66 columns -
15 fixed gives 1592, 52 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 36 rows 19 columns
Cbc0010I After 9100 nodes, 619 on tree, 979.17069 best solution, best possible
903.89028 (126.93 seconds)
Cbc0010I After 9200 nodes, 607 on tree, 979.17069 best solution, best possible
903.89028 (128.31 seconds)
Cbc0010I After 9300 nodes, 600 on tree, 979.17069 best solution, best possible
903.89028 (129.89 seconds)
Cbc0010I After 9400 nodes, 596 on tree, 979.17069 best solution, best possible
903.89028 (131.42 seconds)
Cbc0010I After 9500 nodes, 597 on tree, 979.17069 best solution, best possible
903.89028 (132.80 seconds)
Cbc0010I After 9600 nodes, 596 on tree, 979.17069 best solution, best possible
903.89028 (134.18 seconds)
Cbc0010I After 9700 nodes, 595 on tree, 979.17069 best solution, best possible
903.89028 (135.47 seconds)
Cbc0010I After 9800 nodes, 594 on tree, 979.17069 best solution, best possible
903.89028 (136.92 seconds)
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Cbc0010I After 9900 nodes, 600 on tree, 979.17069 best solution, best possible
903.89028 (138.18 seconds)
Cbc0010I After 10000 nodes, 596 on tree, 979.17069 best solution, best possible
903.89028 (139.41 seconds)
Cbc0010I After 10100 nodes, 592 on tree, 979.17069 best solution, best possible
903.89028 (140.73 seconds)
Cbc0010I After 10200 nodes, 587 on tree, 979.17069 best solution, best possible
903.89028 (141.85 seconds)
Cbc0010I After 10300 nodes, 590 on tree, 979.17069 best solution, best possible
903.89028 (143.14 seconds)
Cbc0010I After 10400 nodes, 586 on tree, 979.17069 best solution, best possible
903.89028 (144.27 seconds)
Cbc0010I After 10500 nodes, 583 on tree, 979.17069 best solution, best possible
903.89028 (145.24 seconds)
Cbc0010I After 10600 nodes, 586 on tree, 979.17069 best solution, best possible
903.89028 (146.23 seconds)
Cbc0010I After 10700 nodes, 588 on tree, 979.17069 best solution, best possible
903.89028 (147.57 seconds)
Cbc0010I After 10800 nodes, 589 on tree, 979.17069 best solution, best possible
903.89028 (148.94 seconds)
Cbc0010I After 10900 nodes, 590 on tree, 979.17069 best solution, best possible
903.89028 (150.07 seconds)
Cbc0010I After 11000 nodes, 589 on tree, 979.17069 best solution, best possible
903.89028 (151.10 seconds)
Cbc0010I After 11100 nodes, 633 on tree, 979.17069 best solution, best possible
906.25077 (156.85 seconds)
Cbc0010I After 11200 nodes, 683 on tree, 979.17069 best solution, best possible
907.26503 (161.30 seconds)
Cbc0010I After 11300 nodes, 733 on tree, 979.17069 best solution, best possible
907.7977 (165.82 seconds)
Cbc0010I After 11400 nodes, 783 on tree, 979.17069 best solution, best possible
908.35339 (170.15 seconds)
Cbc0010I After 11500 nodes, 833 on tree, 979.17069 best solution, best possible
908.64329 (173.63 seconds)
Cbc0010I After 11600 nodes, 883 on tree, 979.17069 best solution, best possible
908.96391 (177.44 seconds)
Cbc0010I After 11700 nodes, 933 on tree, 979.17069 best solution, best possible
909.17669 (181.06 seconds)
Cbc0010I After 11800 nodes, 982 on tree, 979.17069 best solution, best possible
909.38186 (184.39 seconds)
Cbc0010I After 11900 nodes, 1032 on tree, 979.17069 best solution, best possible
909.63134 (187.50 seconds)
Cbc0010I After 12000 nodes, 1081 on tree, 979.17069 best solution, best possible
909.82103 (190.64 seconds)
Cbc0010I After 12100 nodes, 1130 on tree, 979.17069 best solution, best possible
910.00849 (193.85 seconds)
Cbc0010I After 12200 nodes, 1179 on tree, 979.17069 best solution, best possible
910.15948 (197.15 seconds)
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Cbc0010I After 12300 nodes, 1225 on tree, 979.17069 best solution, best possible
910.319 (200.28 seconds)
Cbc0010I After 12400 nodes, 1275 on tree, 979.17069 best solution, best possible
910.42315 (203.58 seconds)
Cbc0010I After 12500 nodes, 1322 on tree, 979.17069 best solution, best possible
910.588 (207.17 seconds)
Cbc0010I After 12600 nodes, 1370 on tree, 979.17069 best solution, best possible
910.74854 (210.30 seconds)
Cbc0010I After 12700 nodes, 1420 on tree, 979.17069 best solution, best possible
910.96995 (213.44 seconds)
Cbc0010I After 12800 nodes, 1469 on tree, 979.17069 best solution, best possible
911.1601 (216.70 seconds)
Cbc0010I After 12900 nodes, 1516 on tree, 979.17069 best solution, best possible
911.32233 (219.92 seconds)
Cbc0010I After 13000 nodes, 1564 on tree, 979.17069 best solution, best possible
911.44736 (223.25 seconds)
Cbc0010I After 13100 nodes, 1609 on tree, 979.17069 best solution, best possible
911.44736 (224.63 seconds)
Cbc0010I After 13200 nodes, 1601 on tree, 979.17069 best solution, best possible
911.44736 (226.19 seconds)
Cbc0010I After 13300 nodes, 1612 on tree, 979.17069 best solution, best possible
911.44736 (227.47 seconds)
Cbc0010I After 13400 nodes, 1608 on tree, 979.17069 best solution, best possible
911.44736 (228.49 seconds)
Cbc0010I After 13500 nodes, 1606 on tree, 979.17069 best solution, best possible
911.44736 (229.58 seconds)
Cbc0010I After 13600 nodes, 1605 on tree, 979.17069 best solution, best possible
911.44736 (230.70 seconds)
Cbc0010I After 13700 nodes, 1605 on tree, 979.17069 best solution, best possible
911.44736 (231.84 seconds)
Cbc0010I After 13800 nodes, 1603 on tree, 979.17069 best solution, best possible
911.44736 (233.27 seconds)
Cbc0010I After 13900 nodes, 1612 on tree, 979.17069 best solution, best possible
911.44736 (234.68 seconds)
Cbc0010I After 14000 nodes, 1609 on tree, 979.17069 best solution, best possible
911.44736 (236.39 seconds)
Cbc0010I After 14100 nodes, 1658 on tree, 979.17069 best solution, best possible
911.58819 (239.85 seconds)
Cbc0010I After 14200 nodes, 1707 on tree, 979.17069 best solution, best possible
911.75453 (243.17 seconds)
Cbc0010I After 14300 nodes, 1755 on tree, 979.17069 best solution, best possible
911.92339 (246.33 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2090 rows 90 columns -
15 fixed gives 1716, 54 - ok now
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 107 rows 46 columns
Cbc0010I After 14400 nodes, 1803 on tree, 979.17069 best solution, best possible
912.12146 (250.25 seconds)
Cbc0010I After 14500 nodes, 1852 on tree, 979.17069 best solution, best possible
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912.27618 (253.99 seconds)
Cbc0010I After 14600 nodes, 1901 on tree, 979.17069 best solution, best possible
912.4382 (257.40 seconds)
Cbc0010I After 14700 nodes, 1950 on tree, 979.17069 best solution, best possible
912.5701 (261.13 seconds)
Cbc0010I After 14800 nodes, 2000 on tree, 979.17069 best solution, best possible
912.67592 (264.70 seconds)
Cbc0010I After 14900 nodes, 2049 on tree, 979.17069 best solution, best possible
912.78215 (268.16 seconds)
Cbc0010I After 15000 nodes, 2099 on tree, 979.17069 best solution, best possible
912.90864 (271.78 seconds)
Cbc0010I After 15100 nodes, 2149 on tree, 979.17069 best solution, best possible
912.98775 (274.81 seconds)
Cbc0010I After 15200 nodes, 2199 on tree, 979.17069 best solution, best possible
913.08058 (278.17 seconds)
Cbc0010I After 15300 nodes, 2246 on tree, 979.17069 best solution, best possible
913.15208 (281.51 seconds)
Cbc0010I After 15400 nodes, 2294 on tree, 979.17069 best solution, best possible
913.26515 (284.55 seconds)
Cbc0010I After 15500 nodes, 2342 on tree, 979.17069 best solution, best possible
913.34756 (287.89 seconds)
Cbc0010I After 15600 nodes, 2392 on tree, 979.17069 best solution, best possible
913.41666 (290.62 seconds)
Cbc0010I After 15700 nodes, 2440 on tree, 979.17069 best solution, best possible
913.50598 (293.86 seconds)
Cbc0010I After 15800 nodes, 2488 on tree, 979.17069 best solution, best possible
913.57496 (297.33 seconds)
Cbc0010I After 15900 nodes, 2536 on tree, 979.17069 best solution, best possible
913.65184 (300.07 seconds)
Cbc0010I After 16000 nodes, 2585 on tree, 979.17069 best solution, best possible
913.72731 (303.34 seconds)
Cbc0010I After 16100 nodes, 2634 on tree, 979.17069 best solution, best possible
913.78709 (306.54 seconds)
Cbc0010I After 16200 nodes, 2681 on tree, 979.17069 best solution, best possible
913.88081 (309.45 seconds)
Cbc0010I After 16300 nodes, 2731 on tree, 979.17069 best solution, best possible
913.92528 (312.72 seconds)
Cbc0010I After 16400 nodes, 2781 on tree, 979.17069 best solution, best possible
913.98776 (315.80 seconds)
Cbc0010I After 16500 nodes, 2829 on tree, 979.17069 best solution, best possible
914.03892 (319.13 seconds)
Cbc0004I Integer solution of 943.38969 found after 1233675 iterations and 16541
nodes (320.61 seconds)
Cbc0010I After 16600 nodes, 2577 on tree, 943.38969 best solution, best possible
914.06771 (321.67 seconds)
Cbc0010I After 16700 nodes, 2623 on tree, 943.38969 best solution, best possible
914.06771 (323.31 seconds)
Cbc0010I After 16800 nodes, 2672 on tree, 943.38969 best solution, best possible
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914.06771 (325.22 seconds)
Cbc0010I After 16900 nodes, 2721 on tree, 943.38969 best solution, best possible
914.06771 (327.09 seconds)
Cbc0010I After 17000 nodes, 2763 on tree, 943.38969 best solution, best possible
914.06771 (328.82 seconds)
Cbc0010I After 17100 nodes, 2768 on tree, 943.38969 best solution, best possible
914.06771 (330.38 seconds)
Cbc0010I After 17200 nodes, 2773 on tree, 943.38969 best solution, best possible
914.06771 (331.35 seconds)
Cbc0010I After 17300 nodes, 2772 on tree, 943.38969 best solution, best possible
914.06771 (332.23 seconds)
Cbc0010I After 17400 nodes, 2770 on tree, 943.38969 best solution, best possible
914.06771 (333.20 seconds)
Cbc0010I After 17500 nodes, 2769 on tree, 943.38969 best solution, best possible
914.06771 (334.14 seconds)
Cbc0010I After 17600 nodes, 2765 on tree, 943.38969 best solution, best possible
914.06771 (335.19 seconds)
Cbc0010I After 17700 nodes, 2767 on tree, 943.38969 best solution, best possible
914.06771 (336.16 seconds)
Cbc0010I After 17800 nodes, 2774 on tree, 943.38969 best solution, best possible
914.06771 (337.29 seconds)
Cbc0010I After 17900 nodes, 2776 on tree, 943.38969 best solution, best possible
914.06771 (338.35 seconds)
Cbc0010I After 18000 nodes, 2765 on tree, 943.38969 best solution, best possible
914.06771 (339.44 seconds)
Cbc0010I After 18100 nodes, 2815 on tree, 943.38969 best solution, best possible
914.12424 (342.83 seconds)
Cbc0010I After 18200 nodes, 2862 on tree, 943.38969 best solution, best possible
914.18903 (346.14 seconds)
Cbc0010I After 18300 nodes, 2909 on tree, 943.38969 best solution, best possible
914.26107 (349.14 seconds)
Cbc0010I After 18400 nodes, 2956 on tree, 943.38969 best solution, best possible
914.31841 (352.61 seconds)
Cbc0010I After 18500 nodes, 3002 on tree, 943.38969 best solution, best possible
914.38684 (355.96 seconds)
Cbc0010I After 18600 nodes, 3048 on tree, 943.38969 best solution, best possible
914.46666 (359.24 seconds)
Cbc0010I After 18700 nodes, 3096 on tree, 943.38969 best solution, best possible
914.54426 (362.62 seconds)
Cbc0010I After 18800 nodes, 3143 on tree, 943.38969 best solution, best possible
914.59966 (365.74 seconds)
Cbc0010I After 18900 nodes, 3192 on tree, 943.38969 best solution, best possible
914.65708 (369.15 seconds)
Cbc0010I After 19000 nodes, 3234 on tree, 943.38969 best solution, best possible
914.71212 (371.77 seconds)
Cbc0004I Integer solution of 920.79029 found after 1441173 iterations and 19016
nodes (372.28 seconds)
Cbc0010I After 19100 nodes, 1990 on tree, 920.79029 best solution, best possible
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914.72503 (373.33 seconds)
Cbc0010I After 19200 nodes, 1993 on tree, 920.79029 best solution, best possible
914.72503 (374.67 seconds)
Cbc0010I After 19300 nodes, 1994 on tree, 920.79029 best solution, best possible
914.72503 (375.78 seconds)
Cbc0010I After 19400 nodes, 1992 on tree, 920.79029 best solution, best possible
914.72503 (376.82 seconds)
Cbc0004I Integer solution of 919.02996 found after 1460844 iterations and 19423
nodes (377.04 seconds)
Cbc0010I After 19500 nodes, 1551 on tree, 919.02996 best solution, best possible
914.72503 (377.94 seconds)
Cbc0010I After 19600 nodes, 1544 on tree, 919.02996 best solution, best possible
914.72503 (379.07 seconds)
Cbc0010I After 19700 nodes, 1531 on tree, 919.02996 best solution, best possible
914.72503 (380.15 seconds)
Cbc0010I After 19800 nodes, 1519 on tree, 919.02996 best solution, best possible
914.72503 (381.24 seconds)
Cbc0010I After 19900 nodes, 1507 on tree, 919.02996 best solution, best possible
914.72503 (382.51 seconds)
Cbc0010I After 20000 nodes, 1501 on tree, 919.02996 best solution, best possible
914.72503 (383.76 seconds)
Cbc0010I After 20100 nodes, 1508 on tree, 919.02996 best solution, best possible
914.8218 (386.26 seconds)
Cbc0010I After 20200 nodes, 1520 on tree, 919.02996 best solution, best possible
914.89656 (388.74 seconds)
Cbc0010I After 20300 nodes, 1524 on tree, 919.02996 best solution, best possible
914.99856 (390.85 seconds)
Cbc0010I After 20400 nodes, 1535 on tree, 919.02996 best solution, best possible
915.06824 (393.34 seconds)
Cbc0010I After 20500 nodes, 1549 on tree, 919.02996 best solution, best possible
915.1447 (395.69 seconds)
Cbc0010I After 20600 nodes, 1551 on tree, 919.02996 best solution, best possible
915.19295 (397.79 seconds)
Cbc0010I After 20700 nodes, 1557 on tree, 919.02996 best solution, best possible
915.2613 (399.96 seconds)
Cbc0010I After 20800 nodes, 1565 on tree, 919.02996 best solution, best possible
915.33598 (402.38 seconds)
Cbc0010I After 20900 nodes, 1557 on tree, 919.02996 best solution, best possible
915.39542 (404.25 seconds)
Cbc0010I After 21000 nodes, 1550 on tree, 919.02996 best solution, best possible
915.47403 (406.48 seconds)
Cbc0010I After 21100 nodes, 1531 on tree, 919.02996 best solution, best possible
915.47403 (407.57 seconds)
Cbc0010I After 21200 nodes, 1497 on tree, 919.02996 best solution, best possible
915.47403 (408.70 seconds)
Cbc0010I After 21300 nodes, 1469 on tree, 919.02996 best solution, best possible
915.47403 (409.63 seconds)
Cbc0010I After 21400 nodes, 1443 on tree, 919.02996 best solution, best possible
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915.47403 (410.71 seconds)
Cbc0010I After 21500 nodes, 1412 on tree, 919.02996 best solution, best possible
915.47403 (411.90 seconds)
Cbc0010I After 21600 nodes, 1376 on tree, 919.02996 best solution, best possible
915.47403 (413.25 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2251 rows 92 columns -
12 fixed gives 2050, 55 - still too large
Cbc0010I After 21700 nodes, 1351 on tree, 919.02996 best solution, best possible
915.47403 (414.37 seconds)
Cbc0010I After 21800 nodes, 1323 on tree, 919.02996 best solution, best possible
915.47403 (415.55 seconds)
Cbc0010I After 21900 nodes, 1304 on tree, 919.02996 best solution, best possible
915.47403 (416.72 seconds)
Cbc0010I After 22000 nodes, 1278 on tree, 919.02996 best solution, best possible
915.47403 (417.94 seconds)
Cbc0010I After 22100 nodes, 1287 on tree, 919.02996 best solution, best possible
915.53846 (420.53 seconds)
Cbc0010I After 22200 nodes, 1284 on tree, 919.02996 best solution, best possible
915.61601 (422.69 seconds)
Cbc0010I After 22300 nodes, 1282 on tree, 919.02996 best solution, best possible
915.71732 (424.82 seconds)
Cbc0010I After 22400 nodes, 1286 on tree, 919.02996 best solution, best possible
915.77976 (427.30 seconds)
Cbc0010I After 22500 nodes, 1296 on tree, 919.02996 best solution, best possible
915.83521 (430.59 seconds)
Cbc0010I After 22600 nodes, 1294 on tree, 919.02996 best solution, best possible
915.91385 (432.99 seconds)
Cbc0010I After 22700 nodes, 1294 on tree, 919.02996 best solution, best possible
915.98605 (435.39 seconds)
Cbc0010I After 22800 nodes, 1285 on tree, 919.02996 best solution, best possible
916.05553 (437.17 seconds)
Cbc0010I After 22900 nodes, 1288 on tree, 919.02996 best solution, best possible
916.10119 (439.28 seconds)
Cbc0010I After 23000 nodes, 1289 on tree, 919.02996 best solution, best possible
916.15985 (441.41 seconds)
Cbc0010I After 23100 nodes, 1283 on tree, 919.02996 best solution, best possible
916.23452 (443.18 seconds)
Cbc0010I After 23200 nodes, 1275 on tree, 919.02996 best solution, best possible
916.30157 (444.83 seconds)
Cbc0010I After 23300 nodes, 1272 on tree, 919.02996 best solution, best possible
916.35423 (446.74 seconds)
Cbc0010I After 23400 nodes, 1267 on tree, 919.02996 best solution, best possible
916.39409 (448.62 seconds)
Cbc0010I After 23500 nodes, 1263 on tree, 919.02996 best solution, best possible
916.44703 (450.42 seconds)
Cbc0010I After 23600 nodes, 1254 on tree, 919.02996 best solution, best possible
916.50549 (452.11 seconds)
Cbc0010I After 23700 nodes, 1241 on tree, 919.02996 best solution, best possible
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916.57047 (453.95 seconds)
Cbc0010I After 23800 nodes, 1228 on tree, 919.02996 best solution, best possible
916.62998 (455.85 seconds)
Cbc0010I After 23900 nodes, 1212 on tree, 919.02996 best solution, best possible
916.69992 (457.65 seconds)
Cbc0010I After 24000 nodes, 1198 on tree, 919.02996 best solution, best possible
916.74434 (459.40 seconds)
Cbc0010I After 24100 nodes, 1178 on tree, 919.02996 best solution, best possible
916.80548 (460.96 seconds)
Cbc0010I After 24200 nodes, 1157 on tree, 919.02996 best solution, best possible
916.87037 (462.68 seconds)
Cbc0010I After 24300 nodes, 1141 on tree, 919.02996 best solution, best possible
916.9311 (464.36 seconds)
Cbc0010I After 24400 nodes, 1127 on tree, 919.02996 best solution, best possible
916.98703 (466.06 seconds)
Cbc0010I After 24500 nodes, 1103 on tree, 919.02996 best solution, best possible
917.05014 (467.52 seconds)
Cbc0010I After 24600 nodes, 1086 on tree, 919.02996 best solution, best possible
917.1043 (468.97 seconds)
Cbc0010I After 24700 nodes, 1068 on tree, 919.02996 best solution, best possible
917.15067 (470.67 seconds)
Cbc0010I After 24800 nodes, 1047 on tree, 919.02996 best solution, best possible
917.20594 (472.24 seconds)
Cbc0010I After 24900 nodes, 1025 on tree, 919.02996 best solution, best possible
917.25478 (473.91 seconds)
Cbc0010I After 25000 nodes, 1003 on tree, 919.02996 best solution, best possible
917.31314 (475.33 seconds)
Cbc0010I After 25100 nodes, 968 on tree, 919.02996 best solution, best possible
917.31314 (476.14 seconds)
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 2208 rows 93 columns -
10 fixed gives 1963, 55 - still too large
Cbc0038I Full problem 2452 rows 2499 columns, reduced to 158 rows 33 columns
Cbc0010I After 25200 nodes, 929 on tree, 919.02996 best solution, best possible
917.31314 (477.16 seconds)
Cbc0010I After 25300 nodes, 895 on tree, 919.02996 best solution, best possible
917.31314 (478.15 seconds)
Cbc0010I After 25400 nodes, 857 on tree, 919.02996 best solution, best possible
917.31314 (479.20 seconds)
Cbc0010I After 25500 nodes, 820 on tree, 919.02996 best solution, best possible
917.31314 (480.21 seconds)
Cbc0010I After 25600 nodes, 790 on tree, 919.02996 best solution, best possible
917.31314 (481.37 seconds)
Cbc0010I After 25700 nodes, 757 on tree, 919.02996 best solution, best possible
917.31314 (482.28 seconds)
Cbc0010I After 25800 nodes, 722 on tree, 919.02996 best solution, best possible
917.31314 (483.39 seconds)
Cbc0010I After 25900 nodes, 693 on tree, 919.02996 best solution, best possible
917.31314 (484.42 seconds)
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Cbc0010I After 26000 nodes, 666 on tree, 919.02996 best solution, best possible
917.31314 (485.28 seconds)
Cbc0010I After 26100 nodes, 647 on tree, 919.02996 best solution, best possible
917.40226 (486.86 seconds)
Cbc0010I After 26200 nodes, 630 on tree, 919.02996 best solution, best possible
917.48233 (488.47 seconds)
Cbc0010I After 26300 nodes, 608 on tree, 919.02996 best solution, best possible
917.56366 (489.85 seconds)
Cbc0010I After 26400 nodes, 580 on tree, 919.02996 best solution, best possible
917.63043 (491.50 seconds)
Cbc0010I After 26500 nodes, 552 on tree, 919.02996 best solution, best possible
917.70459 (493.12 seconds)
Cbc0010I After 26600 nodes, 528 on tree, 919.02996 best solution, best possible
917.79817 (494.66 seconds)
Cbc0010I After 26700 nodes, 505 on tree, 919.02996 best solution, best possible
917.87065 (496.28 seconds)
Cbc0010I After 26800 nodes, 474 on tree, 919.02996 best solution, best possible
917.94654 (497.75 seconds)
Cbc0010I After 26900 nodes, 449 on tree, 919.02996 best solution, best possible
918.00802 (499.32 seconds)
Cbc0010I After 27000 nodes, 424 on tree, 919.02996 best solution, best possible
918.07754 (500.52 seconds)
Cbc0010I After 27100 nodes, 395 on tree, 919.02996 best solution, best possible
918.14282 (501.78 seconds)
Cbc0010I After 27200 nodes, 365 on tree, 919.02996 best solution, best possible
918.2089 (502.95 seconds)
Cbc0010I After 27300 nodes, 335 on tree, 919.02996 best solution, best possible
918.28677 (504.18 seconds)
Cbc0010I After 27400 nodes, 301 on tree, 919.02996 best solution, best possible
918.38499 (505.38 seconds)
Cbc0010I After 27500 nodes, 263 on tree, 919.02996 best solution, best possible
918.45757 (506.43 seconds)
Cbc0010I After 27600 nodes, 229 on tree, 919.02996 best solution, best possible
918.53523 (507.71 seconds)
Cbc0010I After 27700 nodes, 191 on tree, 919.02996 best solution, best possible
918.62149 (508.88 seconds)
Cbc0010I After 27800 nodes, 150 on tree, 919.02996 best solution, best possible
918.70251 (509.91 seconds)
Cbc0010I After 27900 nodes, 111 on tree, 919.02996 best solution, best possible
918.77328 (511.21 seconds)
Cbc0010I After 28000 nodes, 71 on tree, 919.02996 best solution, best possible
918.89172 (512.20 seconds)
Cbc0010I After 28100 nodes, 23 on tree, 919.02996 best solution, best possible
918.99579 (513.06 seconds)
Cbc0001I Search completed - best objective 919.0299593114161, took 2139709
iterations and 28148 nodes (513.57 seconds)
Cbc0032I Strong branching done 18106 times (138063 iterations), fathomed 1004
nodes and fixed 162 variables
```

```
Cbc0035I Maximum depth 131, 2771020 variables fixed on reduced cost
Cuts at root node changed objective from 771.411 to 903.89
Probing was tried 14 times and created 19 cuts of which 0 were active after
adding rounds of cuts (0.239 seconds)
Gomory was tried 20303 times and created 971 cuts of which 0 were active after
adding rounds of cuts (23.367 seconds)
Knapsack was tried 14 times and created 3 cuts of which 0 were active after
adding rounds of cuts (0.026 seconds)
Clique was tried 14 times and created 0 cuts of which 0 were active after adding
rounds of cuts (0.002 seconds)
MixedIntegerRounding2 was tried 20314 times and created 6630 cuts of which 0
were active after adding rounds of cuts (35.049 seconds)
FlowCover was tried 14 times and created 0 cuts of which 0 were active after
adding rounds of cuts (0.031 seconds)
TwoMirCuts was tried 20303 times and created 45393 cuts of which 0 were active
after adding rounds of cuts (18.321 seconds)
ZeroHalf was tried 20314 times and created 13312 cuts of which 0 were active
after adding rounds of cuts (101.077 seconds)

Result - Optimal solution found

Objective value:                919.02995931
Enumerated nodes:               28148
Total iterations:               2139709
Time (CPU seconds):             512.37
Time (Wallclock seconds):       513.61

Option for printingOptions changed from normal to all
Total time (CPU seconds):       512.38   (Wallclock seconds):       513.62

CPU times: user 85.7 ms, sys: 4.24 ms, total: 89.9 ms
Wall time: 8min 33s
Optimal
```

[121]:
```python
non_zero_edges = [ e for e in x if value(x[e]) != 0 ]

def get_next_site(parent):
    '''helper function to get the next edge'''
    edges = [e for e in non_zero_edges if e[0]==parent]
    for e in edges:
        non_zero_edges.remove(e)
    return edges
```

[122]:
```python
tours = get_next_site(0)
tours = [ [e] for e in tours ]

for t in tours:
```

```
    while t[-1][1] !=0:
        t.append(get_next_site(t[-1][1])[-1])
```

[124]:
```
tours
```

[124]:
```
[[(0, 38),
  (38, 21),
  (21, 13),
  (13, 15),
  (15, 32),
  (32, 27),
  (27, 37),
  (37, 16),
  (16, 2),
  (2, 47),
  (47, 35),
  (35, 25),
  (25, 40),
  (40, 23),
  (23, 12),
  (12, 9),
  (9, 48),
  (48, 22),
  (22, 41),
  (41, 39),
  (39, 1),
  (1, 46),
  (46, 33),
  (33, 36),
  (36, 34),
  (34, 26),
  (26, 10),
  (10, 31),
  (31, 28),
  (28, 45),
  (45, 24),
  (24, 42),
  (42, 17),
  (17, 3),
  (3, 8),
  (8, 18),
  (18, 29),
  (29, 30),
  (30, 19),
  (19, 7),
  (7, 5),
  (5, 11),
```

```
  (11, 44),
  (44, 4),
  (4, 20),
  (20, 14),
  (14, 43),
  (43, 6),
  (6, 49),
  (49, 0)]]
```

[143]:
```
tours_list_new1=[]
tours_list_new=[]
for i in range(len(tours)):
    for j in range(len(tours[i])):
        tours_list=list(tours[i][j])
        tours_list[0]=str(tours_list[0])
        tours_list[1]=str(tours_list[1])
        tours_list_new.append(tuple(tours_list))
tours_list_new1.append(tours_list_new)
```

[146]:
```
tours=tours_list_new1
```

[147]:
```
for t in tours_list_new1:
    print(' -> '.join([ a for a,b in t]+['0']))
```

```
0 -> 38 -> 21 -> 13 -> 15 -> 32 -> 27 -> 37 -> 16 -> 2 -> 47 -> 35 -> 25 -> 40
-> 23 -> 12 -> 9 -> 48 -> 22 -> 41 -> 39 -> 1 -> 46 -> 33 -> 36 -> 34 -> 26 ->
10 -> 31 -> 28 -> 45 -> 24 -> 42 -> 17 -> 3 -> 8 -> 18 -> 29 -> 30 -> 19 -> 7 ->
5 -> 11 -> 44 -> 4 -> 20 -> 14 -> 43 -> 6 -> 49 -> 0
```

[155]:
```
totalTime = 0;
for t in tours:
    time = 0
    for i in range(0, len(t)):
        time += travelTIme.loc[int(t[i][0]), int(t[i][1])]
#         print(flighttime.loc[t[i][0], t[i][1]])
#     print(time)
    if time > totalTime:
        totalTime = time
print(totalTime)
```

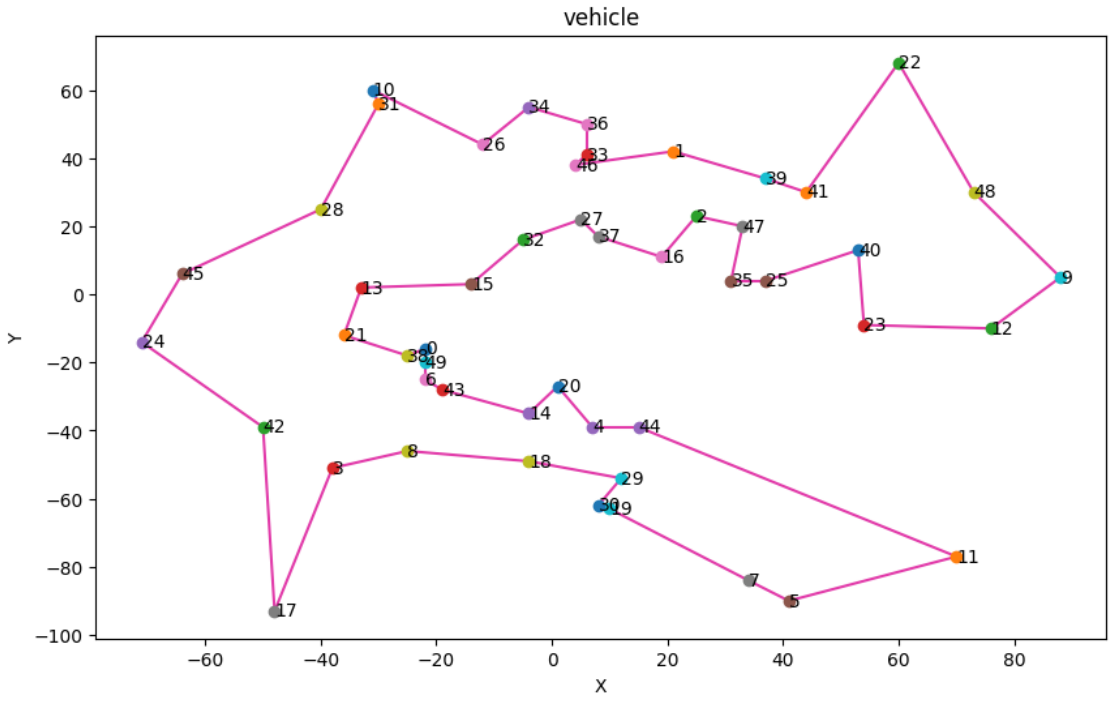
```
1102.8359511736512
```

[172]:
```
plt.figure(figsize=(10,6))
#draw the tours
colors = [np.random.rand(3) for i in range(len(tours))]
for t,c in zip(tours,colors):
    for a,b in t:
        a=int(a)
```

```
        b=int(b)
        p1,p2 = positions[a], positions[b]
        plt.plot([p1[0],p2[0]],[p1[1],p2[1]], color=c)

#draw the map again
for s in positions:
    p = positions[s]
    plt.plot(p[0],p[1],'o')
    plt.text(p[0]+.
 ↪01,p[1],s,horizontalalignment='left',verticalalignment='center')

plt.title('%d '%K + 'vehicles' if K > 1 else 'vehicle')
plt.xlabel('X')
plt.ylabel('Y')
# plt.gca().axis('off')
plt.show()
```



[170]:
```
print('Longest time spent:', totalTime, '(min)')
print('Total distance:', value(prob.objective), '(km)')
```

```
Longest time spent: 1102.8359511736512 (min)
Total distance: 919.0299593113762 (km)
```