Case – Scheduling Student Volunteers for the INFORMS Annual Meeting

October 25, 2017

1 Introduction

After much consideration, we decided to use the `gurobipy` package to solve this LP problem

```
In [19]: from gurobipy import *
         import pandas

         i_set = [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14]
         j_set = ['1s1', '2s1','3m1','4m1','5t1','6t1','5t2','6t2','5t3','6t3','7w1','8w1','7w2'

         # create a LP model
         model = Model()
```

2 Variables

Now we can set the variables

```
In [20]: # Set Variables
         x = {}
         for i in i_set:
             for j in j_set:
                 x[str(i)+'~'+j] = model.addVar(vtype=GRB.BINARY, name=str(i) + '~' + j)

         model.update()
         x

Out[20]: {'10~1s1': <gurobi.Var 10~1s1>,
          '10~2s1': <gurobi.Var 10~2s1>,
          '10~3m1': <gurobi.Var 10~3m1>,
          '10~4m1': <gurobi.Var 10~4m1>,
          '10~5b': <gurobi.Var 10~5b>,
          '10~5t1': <gurobi.Var 10~5t1>,
          '10~5t2': <gurobi.Var 10~5t2>,
          '10~5t3': <gurobi.Var 10~5t3>,
          '10~6b': <gurobi.Var 10~6b>,
```

```
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```

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'7~3m1': <gurobi.Var 7~3m1>,
```

```
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'9~7b': <gurobi.Var 9~7b>,
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'9~7w2': <gurobi.Var 9~7w2>,
```

```
'9~8b': <gurobi.Var 9~8b>,
'9~8w1': <gurobi.Var 9~8w1>,
'9~8w2': <gurobi.Var 9~8w2>}
```

3   Objective function

Now we can write down the objective function

```
In [15]: # Set objective
         model.setObjective(quicksum(x[key] for key in x.keys()), GRB.MINIMIZE)
```

4   Constraints

Now we can write down the constraints

```
In [16]: # Add constraints
         c = {}

         # 1. meet the conference demands
         conference_demands = [2,2,2,2,2,2,1,1,1,1,2,2,1,1]
         c_i = 0   # conference index
         conference_shift = j_set[:-4] # without '5b'...
         for j in conference_shift:
             c['x_i~' + j] = model.addConstr(quicksum(x[str(i)+'~' + j] for i in i_set) >= confe
             c_i += 1

         # 2. meet the volunteers availability
         availability = pandas.read_excel('Availability.xlsx').transpose()
         for i in i_set:
             for j in j_set:
                 c[str(i)+'~'+j +" <= A_" + str(i) + '~' + j] = model.addConstr(x[str(i)+'~'+j]

         # 3. special constraints
         # 3.1 student 2 and student 5
         c["x_2~j <= 1"] = model.addConstr(quicksum(x['2~' + j] for j in j_set) <= 1, name="x_2~
         c["x_5~j <= 1"] = model.addConstr(quicksum(x['5~' + j] for j in j_set) <= 1, name="x_5~

         # 3.2
         c["x_i~5b >= 1"] = model.addConstr(quicksum(x[str(i)+'~5b'] for i in i_set) >= 1, name=
         c["x_i~6b >= 1"] = model.addConstr(quicksum(x[str(i)+'~6b'] for i in i_set) >= 1, name=
         c["x_i~7b >= 1"] = model.addConstr(quicksum(x[str(i)+'~7b'] for i in i_set) >= 1, name=
         c["x_i~8b >= 1"] = model.addConstr(quicksum(x[str(i)+'~8b'] for i in i_set) >= 1, name=

         # 4. no students can be assigned to different location during the same shift
         for i in i_set:
             all_location = ['5t1', '5t2', '5t3', '5b']
```

```
        c["x_" + str(i) + "~5(k) <= 1"] = model.addConstr(quicksum(x[str(i)+'~' + k] for k
        all_location = ['6t1', '6t2', '6t3', '6b']
        c["x_" + str(i) + "~6(k) <= 1"] = model.addConstr(quicksum(x[str(i)+'~' + k] for k
        all_location = ['7w1', '7w2', '7b']
        c["x_" + str(i) + "~7(k) <= 1"] = model.addConstr(quicksum(x[str(i)+'~' + k] for k
        all_location = ['8w1', '8w2', '8b']
        c["x_" + str(i) + "~8(k) <= 1"] = model.addConstr(quicksum(x[str(i)+'~' + k] for k


    model.update()

    c
```

Out[16]: {'10~1s1 <= A_10~1s1': <gurobi.Constr 10~1s1 <= A_10~1s1>,
          '10~2s1 <= A_10~2s1': <gurobi.Constr 10~2s1 <= A_10~2s1>,
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'12~6t1 <= A_12~6t1': <gurobi.Constr 12~6t1 <= A_12~6t1>,
'12~6t2 <= A_12~6t2': <gurobi.Constr 12~6t2 <= A_12~6t2>,
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'12~8w1 <= A_12~8w1': <gurobi.Constr 12~8w1 <= A_12~8w1>,
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'14~6t2 <= A_14~6t2': <gurobi.Constr 14~6t2 <= A_14~6t2>,
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'14~7w2 <= A_14~7w2': <gurobi.Constr 14~7w2 <= A_14~7w2>,
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'1~3m1 <= A_1~3m1': <gurobi.Constr 1~3m1 <= A_1~3m1>,
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'5~8w1 <= A_5~8w1': <gurobi.Constr 5~8w1 <= A_5~8w1>,
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'8~6t2 <= A_8~6t2': <gurobi.Constr 8~6t2 <= A_8~6t2>,
```

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'x_12~7(k) <= 1': <gurobi.Constr x_12~7(k) <= 1>,
'x_12~8(k) <= 1': <gurobi.Constr x_12~8(k) <= 1>,
'x_13~5(k) <= 1': <gurobi.Constr x_13~5(k) <= 1>,
'x_13~6(k) <= 1': <gurobi.Constr x_13~6(k) <= 1>,
'x_13~7(k) <= 1': <gurobi.Constr x_13~7(k) <= 1>,
'x_13~8(k) <= 1': <gurobi.Constr x_13~8(k) <= 1>,
'x_14~5(k) <= 1': <gurobi.Constr x_14~5(k) <= 1>,
'x_14~6(k) <= 1': <gurobi.Constr x_14~6(k) <= 1>,
'x_14~7(k) <= 1': <gurobi.Constr x_14~7(k) <= 1>,
'x_14~8(k) <= 1': <gurobi.Constr x_14~8(k) <= 1>,
'x_1~5(k) <= 1': <gurobi.Constr x_1~5(k) <= 1>,
'x_1~6(k) <= 1': <gurobi.Constr x_1~6(k) <= 1>,
'x_1~7(k) <= 1': <gurobi.Constr x_1~7(k) <= 1>,
```

```
'x_1~8(k) <= 1': <gurobi.Constr x_1~8(k) <= 1>,
'x_2~5(k) <= 1': <gurobi.Constr x_2~5(k) <= 1>,
'x_2~6(k) <= 1': <gurobi.Constr x_2~6(k) <= 1>,
'x_2~7(k) <= 1': <gurobi.Constr x_2~7(k) <= 1>,
'x_2~8(k) <= 1': <gurobi.Constr x_2~8(k) <= 1>,
'x_2~j <= 1': <gurobi.Constr x_2~j <= 1>,
'x_3~5(k) <= 1': <gurobi.Constr x_3~5(k) <= 1>,
'x_3~6(k) <= 1': <gurobi.Constr x_3~6(k) <= 1>,
'x_3~7(k) <= 1': <gurobi.Constr x_3~7(k) <= 1>,
'x_3~8(k) <= 1': <gurobi.Constr x_3~8(k) <= 1>,
'x_4~5(k) <= 1': <gurobi.Constr x_4~5(k) <= 1>,
'x_4~6(k) <= 1': <gurobi.Constr x_4~6(k) <= 1>,
'x_4~7(k) <= 1': <gurobi.Constr x_4~7(k) <= 1>,
'x_4~8(k) <= 1': <gurobi.Constr x_4~8(k) <= 1>,
'x_5~5(k) <= 1': <gurobi.Constr x_5~5(k) <= 1>,
'x_5~6(k) <= 1': <gurobi.Constr x_5~6(k) <= 1>,
'x_5~7(k) <= 1': <gurobi.Constr x_5~7(k) <= 1>,
'x_5~8(k) <= 1': <gurobi.Constr x_5~8(k) <= 1>,
'x_5~j <= 1': <gurobi.Constr x_5~j <= 1>,
'x_6~5(k) <= 1': <gurobi.Constr x_6~5(k) <= 1>,
'x_6~6(k) <= 1': <gurobi.Constr x_6~6(k) <= 1>,
'x_6~7(k) <= 1': <gurobi.Constr x_6~7(k) <= 1>,
'x_6~8(k) <= 1': <gurobi.Constr x_6~8(k) <= 1>,
'x_7~5(k) <= 1': <gurobi.Constr x_7~5(k) <= 1>,
'x_7~6(k) <= 1': <gurobi.Constr x_7~6(k) <= 1>,
'x_7~7(k) <= 1': <gurobi.Constr x_7~7(k) <= 1>,
'x_7~8(k) <= 1': <gurobi.Constr x_7~8(k) <= 1>,
'x_8~5(k) <= 1': <gurobi.Constr x_8~5(k) <= 1>,
'x_8~6(k) <= 1': <gurobi.Constr x_8~6(k) <= 1>,
'x_8~7(k) <= 1': <gurobi.Constr x_8~7(k) <= 1>,
'x_8~8(k) <= 1': <gurobi.Constr x_8~8(k) <= 1>,
'x_9~5(k) <= 1': <gurobi.Constr x_9~5(k) <= 1>,
'x_9~6(k) <= 1': <gurobi.Constr x_9~6(k) <= 1>,
'x_9~7(k) <= 1': <gurobi.Constr x_9~7(k) <= 1>,
'x_9~8(k) <= 1': <gurobi.Constr x_9~8(k) <= 1>,
'x_i~1s1': <gurobi.Constr x_i~1s1 >= 2>,
'x_i~2s1': <gurobi.Constr x_i~2s1 >= 2>,
'x_i~3m1': <gurobi.Constr x_i~3m1 >= 2>,
'x_i~4m1': <gurobi.Constr x_i~4m1 >= 2>,
'x_i~5b >= 1': <gurobi.Constr x_i~5b >= 1>,
'x_i~5t1': <gurobi.Constr x_i~5t1 >= 2>,
'x_i~5t2': <gurobi.Constr x_i~5t2 >= 1>,
'x_i~5t3': <gurobi.Constr x_i~5t3 >= 1>,
'x_i~6b >= 1': <gurobi.Constr x_i~6b >= 1>,
'x_i~6t1': <gurobi.Constr x_i~6t1 >= 2>,
'x_i~6t2': <gurobi.Constr x_i~6t2 >= 1>,
'x_i~6t3': <gurobi.Constr x_i~6t3 >= 1>,
'x_i~7b >= 1': <gurobi.Constr x_i~7b >= 1>,
```

```
        'x_i~7w1': <gurobi.Constr x_i~7w1 >= 2>,
        'x_i~7w2': <gurobi.Constr x_i~7w2 >= 1>,
        'x_i~8b >= 1': <gurobi.Constr x_i~8b >= 1>,
        'x_i~8w1': <gurobi.Constr x_i~8w1 >= 2>,
        'x_i~8w2': <gurobi.Constr x_i~8w2 >= 1>}
```

5 Solution

Now, let's get the results

```
In [17]: model.optimize()
         print()
         print("*****Thus the objective value is " + str(model.ObjVal))
```

```
Optimize a model with 328 rows, 252 columns and 736 nonzeros
Variable types: 0 continuous, 252 integer (252 binary)
Coefficient statistics:
  Matrix range      [1e+00, 1e+00]
  Objective range   [1e+00, 1e+00]
  Bounds range      [1e+00, 1e+00]
  RHS range         [1e+00, 2e+00]
Found heuristic solution: objective 26
Presolve removed 280 rows and 121 columns
Presolve time: 0.00s
Presolved: 48 rows, 131 columns, 262 nonzeros
Variable types: 0 continuous, 131 integer (131 binary)

Root relaxation: cutoff, 17 iterations, 0.00 seconds

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

    0     0     cutoff    0        26.00000   26.00000  0.00%     -    0s

Explored 0 nodes (17 simplex iterations) in 0.02 seconds
Thread count was 8 (of 8 available processors)

Solution count 1: 26

Optimal solution found (tolerance 1.00e-04)
Best objective 2.600000000000e+01, best bound 2.600000000000e+01, gap 0.0000%

*****Thus the objective value is 26.0
```

6 The resulting variables

```
In [18]: x
```

```
Out[18]: {'10~1s1': <gurobi.Var 10~1s1 (value 0.0)>,
          '10~2s1': <gurobi.Var 10~2s1 (value 0.0)>,
          '10~3m1': <gurobi.Var 10~3m1 (value 0.0)>,
          '10~4m1': <gurobi.Var 10~4m1 (value 0.0)>,
          '10~5b': <gurobi.Var 10~5b (value 0.0)>,
          '10~5t1': <gurobi.Var 10~5t1 (value 0.0)>,
          '10~5t2': <gurobi.Var 10~5t2 (value 0.0)>,
          '10~5t3': <gurobi.Var 10~5t3 (value 0.0)>,
          '10~6b': <gurobi.Var 10~6b (value 0.0)>,
          '10~6t1': <gurobi.Var 10~6t1 (value 0.0)>,
          '10~6t2': <gurobi.Var 10~6t2 (value 0.0)>,
          '10~6t3': <gurobi.Var 10~6t3 (value 0.0)>,
          '10~7b': <gurobi.Var 10~7b (value 0.0)>,
          '10~7w1': <gurobi.Var 10~7w1 (value 0.0)>,
          '10~7w2': <gurobi.Var 10~7w2 (value 0.0)>,
          '10~8b': <gurobi.Var 10~8b (value 0.0)>,
          '10~8w1': <gurobi.Var 10~8w1 (value 0.0)>,
          '10~8w2': <gurobi.Var 10~8w2 (value 0.0)>,
          '11~1s1': <gurobi.Var 11~1s1 (value 0.0)>,
          '11~2s1': <gurobi.Var 11~2s1 (value 0.0)>,
          '11~3m1': <gurobi.Var 11~3m1 (value 0.0)>,
          '11~4m1': <gurobi.Var 11~4m1 (value 1.0)>,
          '11~5b': <gurobi.Var 11~5b (value 0.0)>,
          '11~5t1': <gurobi.Var 11~5t1 (value 0.0)>,
          '11~5t2': <gurobi.Var 11~5t2 (value 1.0)>,
          '11~5t3': <gurobi.Var 11~5t3 (value 0.0)>,
          '11~6b': <gurobi.Var 11~6b (value 0.0)>,
          '11~6t1': <gurobi.Var 11~6t1 (value 0.0)>,
          '11~6t2': <gurobi.Var 11~6t2 (value 0.0)>,
          '11~6t3': <gurobi.Var 11~6t3 (value 0.0)>,
          '11~7b': <gurobi.Var 11~7b (value 0.0)>,
          '11~7w1': <gurobi.Var 11~7w1 (value 1.0)>,
          '11~7w2': <gurobi.Var 11~7w2 (value 0.0)>,
          '11~8b': <gurobi.Var 11~8b (value 1.0)>,
          '11~8w1': <gurobi.Var 11~8w1 (value 0.0)>,
          '11~8w2': <gurobi.Var 11~8w2 (value 0.0)>,
          '12~1s1': <gurobi.Var 12~1s1 (value 0.0)>,
          '12~2s1': <gurobi.Var 12~2s1 (value 0.0)>,
          '12~3m1': <gurobi.Var 12~3m1 (value 1.0)>,
          '12~4m1': <gurobi.Var 12~4m1 (value 0.0)>,
          '12~5b': <gurobi.Var 12~5b (value 0.0)>,
          '12~5t1': <gurobi.Var 12~5t1 (value 0.0)>,
          '12~5t2': <gurobi.Var 12~5t2 (value 0.0)>,
          '12~5t3': <gurobi.Var 12~5t3 (value 0.0)>,
          '12~6b': <gurobi.Var 12~6b (value 0.0)>,
          '12~6t1': <gurobi.Var 12~6t1 (value 0.0)>,
          '12~6t2': <gurobi.Var 12~6t2 (value 0.0)>,
          '12~6t3': <gurobi.Var 12~6t3 (value 1.0)>,
```

```
'12~7b': <gurobi.Var 12~7b (value 0.0)>,
'12~7w1': <gurobi.Var 12~7w1 (value 0.0)>,
'12~7w2': <gurobi.Var 12~7w2 (value 1.0)>,
'12~8b': <gurobi.Var 12~8b (value 0.0)>,
'12~8w1': <gurobi.Var 12~8w1 (value 0.0)>,
'12~8w2': <gurobi.Var 12~8w2 (value 0.0)>,
'13~1s1': <gurobi.Var 13~1s1 (value 0.0)>,
'13~2s1': <gurobi.Var 13~2s1 (value 0.0)>,
'13~3m1': <gurobi.Var 13~3m1 (value 0.0)>,
'13~4m1': <gurobi.Var 13~4m1 (value 0.0)>,
'13~5b': <gurobi.Var 13~5b (value 0.0)>,
'13~5t1': <gurobi.Var 13~5t1 (value 1.0)>,
'13~5t2': <gurobi.Var 13~5t2 (value 0.0)>,
'13~5t3': <gurobi.Var 13~5t3 (value 0.0)>,
'13~6b': <gurobi.Var 13~6b (value 0.0)>,
'13~6t1': <gurobi.Var 13~6t1 (value 0.0)>,
'13~6t2': <gurobi.Var 13~6t2 (value 0.0)>,
'13~6t3': <gurobi.Var 13~6t3 (value 0.0)>,
'13~7b': <gurobi.Var 13~7b (value 0.0)>,
'13~7w1': <gurobi.Var 13~7w1 (value 0.0)>,
'13~7w2': <gurobi.Var 13~7w2 (value 0.0)>,
'13~8b': <gurobi.Var 13~8b (value 0.0)>,
'13~8w1': <gurobi.Var 13~8w1 (value 0.0)>,
'13~8w2': <gurobi.Var 13~8w2 (value 0.0)>,
'14~1s1': <gurobi.Var 14~1s1 (value 0.0)>,
'14~2s1': <gurobi.Var 14~2s1 (value 0.0)>,
'14~3m1': <gurobi.Var 14~3m1 (value 0.0)>,
'14~4m1': <gurobi.Var 14~4m1 (value 0.0)>,
'14~5b': <gurobi.Var 14~5b (value 1.0)>,
'14~5t1': <gurobi.Var 14~5t1 (value 0.0)>,
'14~5t2': <gurobi.Var 14~5t2 (value 0.0)>,
'14~5t3': <gurobi.Var 14~5t3 (value 0.0)>,
'14~6b': <gurobi.Var 14~6b (value 0.0)>,
'14~6t1': <gurobi.Var 14~6t1 (value 1.0)>,
'14~6t2': <gurobi.Var 14~6t2 (value 0.0)>,
'14~6t3': <gurobi.Var 14~6t3 (value 0.0)>,
'14~7b': <gurobi.Var 14~7b (value 0.0)>,
'14~7w1': <gurobi.Var 14~7w1 (value 0.0)>,
'14~7w2': <gurobi.Var 14~7w2 (value 0.0)>,
'14~8b': <gurobi.Var 14~8b (value 0.0)>,
'14~8w1': <gurobi.Var 14~8w1 (value 0.0)>,
'14~8w2': <gurobi.Var 14~8w2 (value 0.0)>,
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'1~2s1': <gurobi.Var 1~2s1 (value 1.0)>,
'1~3m1': <gurobi.Var 1~3m1 (value 0.0)>,
'1~4m1': <gurobi.Var 1~4m1 (value 0.0)>,
'1~5b': <gurobi.Var 1~5b (value 0.0)>,
'1~5t1': <gurobi.Var 1~5t1 (value 0.0)>,
```

```
'1~5t2': <gurobi.Var 1~5t2 (value 0.0)>,
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'1~6b': <gurobi.Var 1~6b (value 0.0)>,
'1~6t1': <gurobi.Var 1~6t1 (value 0.0)>,
'1~6t2': <gurobi.Var 1~6t2 (value 0.0)>,
'1~6t3': <gurobi.Var 1~6t3 (value 0.0)>,
'1~7b': <gurobi.Var 1~7b (value 0.0)>,
'1~7w1': <gurobi.Var 1~7w1 (value 0.0)>,
'1~7w2': <gurobi.Var 1~7w2 (value 0.0)>,
'1~8b': <gurobi.Var 1~8b (value 0.0)>,
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'1~8w2': <gurobi.Var 1~8w2 (value 0.0)>,
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'2~2s1': <gurobi.Var 2~2s1 (value 0.0)>,
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'2~4m1': <gurobi.Var 2~4m1 (value 0.0)>,
'2~5b': <gurobi.Var 2~5b (value 0.0)>,
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'2~7b': <gurobi.Var 2~7b (value 0.0)>,
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'2~8b': <gurobi.Var 2~8b (value 0.0)>,
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'3~6t3': <gurobi.Var 3~6t3 (value 0.0)>,
'3~7b': <gurobi.Var 3~7b (value 1.0)>,
'3~7w1': <gurobi.Var 3~7w1 (value 0.0)>,
'3~7w2': <gurobi.Var 3~7w2 (value 0.0)>,
'3~8b': <gurobi.Var 3~8b (value 0.0)>,
'3~8w1': <gurobi.Var 3~8w1 (value 0.0)>,
'3~8w2': <gurobi.Var 3~8w2 (value 0.0)>,
```

```
'4~1s1': <gurobi.Var 4~1s1 (value 0.0)>,
'4~2s1': <gurobi.Var 4~2s1 (value 0.0)>,
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'4~4m1': <gurobi.Var 4~4m1 (value 0.0)>,
'4~5b': <gurobi.Var 4~5b (value 0.0)>,
'4~5t1': <gurobi.Var 4~5t1 (value 0.0)>,
'4~5t2': <gurobi.Var 4~5t2 (value 0.0)>,
'4~5t3': <gurobi.Var 4~5t3 (value 0.0)>,
'4~6b': <gurobi.Var 4~6b (value 0.0)>,
'4~6t1': <gurobi.Var 4~6t1 (value 0.0)>,
'4~6t2': <gurobi.Var 4~6t2 (value 0.0)>,
'4~6t3': <gurobi.Var 4~6t3 (value 0.0)>,
'4~7b': <gurobi.Var 4~7b (value 0.0)>,
'4~7w1': <gurobi.Var 4~7w1 (value 0.0)>,
'4~7w2': <gurobi.Var 4~7w2 (value 0.0)>,
'4~8b': <gurobi.Var 4~8b (value 0.0)>,
'4~8w1': <gurobi.Var 4~8w1 (value 0.0)>,
'4~8w2': <gurobi.Var 4~8w2 (value 0.0)>,
'5~1s1': <gurobi.Var 5~1s1 (value 0.0)>,
'5~2s1': <gurobi.Var 5~2s1 (value 0.0)>,
'5~3m1': <gurobi.Var 5~3m1 (value 1.0)>,
'5~4m1': <gurobi.Var 5~4m1 (value 0.0)>,
'5~5b': <gurobi.Var 5~5b (value 0.0)>,
'5~5t1': <gurobi.Var 5~5t1 (value 0.0)>,
'5~5t2': <gurobi.Var 5~5t2 (value 0.0)>,
'5~5t3': <gurobi.Var 5~5t3 (value 0.0)>,
'5~6b': <gurobi.Var 5~6b (value 0.0)>,
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'5~6t2': <gurobi.Var 5~6t2 (value 0.0)>,
'5~6t3': <gurobi.Var 5~6t3 (value 0.0)>,
'5~7b': <gurobi.Var 5~7b (value 0.0)>,
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'5~7w2': <gurobi.Var 5~7w2 (value 0.0)>,
'5~8b': <gurobi.Var 5~8b (value 0.0)>,
'5~8w1': <gurobi.Var 5~8w1 (value 0.0)>,
'5~8w2': <gurobi.Var 5~8w2 (value 0.0)>,
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'6~2s1': <gurobi.Var 6~2s1 (value 0.0)>,
'6~3m1': <gurobi.Var 6~3m1 (value 0.0)>,
'6~4m1': <gurobi.Var 6~4m1 (value 0.0)>,
'6~5b': <gurobi.Var 6~5b (value 0.0)>,
'6~5t1': <gurobi.Var 6~5t1 (value 1.0)>,
'6~5t2': <gurobi.Var 6~5t2 (value 0.0)>,
'6~5t3': <gurobi.Var 6~5t3 (value 0.0)>,
'6~6b': <gurobi.Var 6~6b (value 0.0)>,
'6~6t1': <gurobi.Var 6~6t1 (value 0.0)>,
'6~6t2': <gurobi.Var 6~6t2 (value 0.0)>,
'6~6t3': <gurobi.Var 6~6t3 (value 0.0)>,
```

```
'6~7b': <gurobi.Var 6~7b (value 0.0)>,
'6~7w1': <gurobi.Var 6~7w1 (value 1.0)>,
'6~7w2': <gurobi.Var 6~7w2 (value 0.0)>,
'6~8b': <gurobi.Var 6~8b (value 0.0)>,
'6~8w1': <gurobi.Var 6~8w1 (value 1.0)>,
'6~8w2': <gurobi.Var 6~8w2 (value 0.0)>,
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'7~2s1': <gurobi.Var 7~2s1 (value 0.0)>,
'7~3m1': <gurobi.Var 7~3m1 (value 0.0)>,
'7~4m1': <gurobi.Var 7~4m1 (value 0.0)>,
'7~5b': <gurobi.Var 7~5b (value 0.0)>,
'7~5t1': <gurobi.Var 7~5t1 (value 0.0)>,
'7~5t2': <gurobi.Var 7~5t2 (value 0.0)>,
'7~5t3': <gurobi.Var 7~5t3 (value 0.0)>,
'7~6b': <gurobi.Var 7~6b (value 0.0)>,
'7~6t1': <gurobi.Var 7~6t1 (value 1.0)>,
'7~6t2': <gurobi.Var 7~6t2 (value 0.0)>,
'7~6t3': <gurobi.Var 7~6t3 (value 0.0)>,
'7~7b': <gurobi.Var 7~7b (value 0.0)>,
'7~7w1': <gurobi.Var 7~7w1 (value 0.0)>,
'7~7w2': <gurobi.Var 7~7w2 (value 0.0)>,
'7~8b': <gurobi.Var 7~8b (value 0.0)>,
'7~8w1': <gurobi.Var 7~8w1 (value 1.0)>,
'7~8w2': <gurobi.Var 7~8w2 (value 0.0)>,
'8~1s1': <gurobi.Var 8~1s1 (value 0.0)>,
'8~2s1': <gurobi.Var 8~2s1 (value 0.0)>,
'8~3m1': <gurobi.Var 8~3m1 (value 0.0)>,
'8~4m1': <gurobi.Var 8~4m1 (value 0.0)>,
'8~5b': <gurobi.Var 8~5b (value 0.0)>,
'8~5t1': <gurobi.Var 8~5t1 (value 0.0)>,
'8~5t2': <gurobi.Var 8~5t2 (value 0.0)>,
'8~5t3': <gurobi.Var 8~5t3 (value 0.0)>,
'8~6b': <gurobi.Var 8~6b (value 0.0)>,
'8~6t1': <gurobi.Var 8~6t1 (value 0.0)>,
'8~6t2': <gurobi.Var 8~6t2 (value 0.0)>,
'8~6t3': <gurobi.Var 8~6t3 (value 0.0)>,
'8~7b': <gurobi.Var 8~7b (value 0.0)>,
'8~7w1': <gurobi.Var 8~7w1 (value 0.0)>,
'8~7w2': <gurobi.Var 8~7w2 (value 0.0)>,
'8~8b': <gurobi.Var 8~8b (value 0.0)>,
'8~8w1': <gurobi.Var 8~8w1 (value 0.0)>,
'8~8w2': <gurobi.Var 8~8w2 (value 0.0)>,
'9~1s1': <gurobi.Var 9~1s1 (value 1.0)>,
'9~2s1': <gurobi.Var 9~2s1 (value 1.0)>,
'9~3m1': <gurobi.Var 9~3m1 (value 0.0)>,
'9~4m1': <gurobi.Var 9~4m1 (value 1.0)>,
'9~5b': <gurobi.Var 9~5b (value 0.0)>,
'9~5t1': <gurobi.Var 9~5t1 (value 0.0)>,
```

```
'9~5t2': <gurobi.Var 9~5t2 (value 0.0)>,
'9~5t3': <gurobi.Var 9~5t3 (value 0.0)>,
'9~6b': <gurobi.Var 9~6b (value 0.0)>,
'9~6t1': <gurobi.Var 9~6t1 (value 0.0)>,
'9~6t2': <gurobi.Var 9~6t2 (value 1.0)>,
'9~6t3': <gurobi.Var 9~6t3 (value 0.0)>,
'9~7b': <gurobi.Var 9~7b (value 0.0)>,
'9~7w1': <gurobi.Var 9~7w1 (value 0.0)>,
'9~7w2': <gurobi.Var 9~7w2 (value 0.0)>,
'9~8b': <gurobi.Var 9~8b (value 0.0)>,
'9~8w1': <gurobi.Var 9~8w1 (value 0.0)>,
'9~8w2': <gurobi.Var 9~8w2 (value 1.0)>}
```