01a_hw_code

September 24, 2023

0.1 Question 1

Equation A The equation $x+y-z=0$ is valid in a linear program because it is a linear equation.

Equation B The equation $x \leq \frac{100}{y}$ is not valid in a linear program because it is a non-linear function.

Equation C The equation $3x+2y \leq \sqrt{5}$ is valid in a linear program because it is a linear function.

Equation D The equation $\sqrt{5}x + 2y = 50$ is valid in a linear program because it is a linear function.

Equation E The equation $\sqrt{5x} + 10y = 100$ is not valid in a linear program because it is a non-linear function as a result of $\sqrt{5x}$.

Equation F The equation $x^2 + y^2 \geq 45$ is not valid in a linear program because it contains quadratic terms.

0.2 Question 6

[ ]:
```
import gurobipy as gp

# Create a new model
model = gp.Model("cutting_stock")

# Orders: [Width, Number of Rolls]
orders = [(5, 150), (7, 200), (9, 300)]

# Generate all combinations to cut 20-foot rolls into widths of 5, 7, and 9 feet
possible_cuts = []
for cut_5 in range(5):
    for cut_7 in range(3):
        for cut_9 in range(3):
            if cut_5 * 5 + cut_7 * 7 + cut_9 * 9 <= 20:
                possible_cuts.append((cut_5, cut_7, cut_9))

# Decision Variables
x = {}
```

```python
for i, cut in enumerate(possible_cuts):
    x[i] = model.addVar(vtype=gp.GRB.INTEGER, name=f"x_{cut}")

# Objective Function: Minimize the total number of 20-foot rolls
model.setObjective(sum(x[i] for i in x), gp.GRB.MINIMIZE)

# Constraints: Meet the total demand for each order
for j, (width, demand) in enumerate(orders):
    model.addConstr(
        sum(x[i] * possible_cuts[i][j] for i in range(len(possible_cuts))) >=␣
 ↪demand,
        name=f"demand_{j}"
    )

# Solve the model
model.optimize()

# Output Results
print("\nOptimal Solution:")
for v in model.getVars():
    if v.x > 0:  # Only show cuts that are actually used
        print(f"{v.varName}: {v.x}")
print(f"Minimum number of 20-foot rolls needed: {model.objVal}")
```

```
Gurobi Optimizer version 10.0.3 build v10.0.3rc0 (win64)

CPU model: Intel(R) Core(TM) i9-10850K CPU @ 3.60GHz, instruction set
[SSE2|AVX|AVX2]
Thread count: 10 physical cores, 20 logical processors, using up to 20 threads

Optimize a model with 3 rows, 15 columns and 20 nonzeros
Model fingerprint: 0xab337bf2
Variable types: 0 continuous, 15 integer (0 binary)
Coefficient statistics:
  Matrix range     [1e+00, 4e+00]
  Objective range  [1e+00, 1e+00]
  Bounds range     [0e+00, 0e+00]
  RHS range        [2e+02, 3e+02]
Found heuristic solution: objective 500.0000000

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```
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  Bounds range     [0e+00, 0e+00]
  RHS range        [2e+02, 3e+02]
Found heuristic solution: objective 500.0000000
Presolve removed 0 rows and 9 columns
Presolve time: 0.00s
Presolved: 3 rows, 6 columns, 10 nonzeros
Variable types: 0 continuous, 6 integer (0 binary)

Root relaxation: objective 2.625000e+02, 4 iterations, 0.00 seconds (0.00 work
units)

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

     0     0  262.50000    0    1  500.00000  262.50000  47.5%     -    0s
H    0     0                       263.0000000  262.50000  0.19%     -    0s
     0     0  262.50000    0    1  263.00000  262.50000  0.19%     -    0s

Explored 1 nodes (4 simplex iterations) in 0.01 seconds (0.00 work units)
Thread count was 20 (of 20 available processors)

Solution count 2: 263 500

Optimal solution found (tolerance 1.00e-04)
Best objective 2.630000000000e+02, best bound 2.630000000000e+02, gap 0.0000%

Optimal Solution:
x_(0, 0, 2): 150.0
x_(1, 2, 0): 100.0
x_(2, 0, 1): 1.0
x_(4, 0, 0): 12.0
Minimum number of 20-foot rolls needed: 263.0
```