Exam 1

Adv. Analytics and Metaheuristics

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1.1 Mathematical Formulation

1.1.1 Sets

Set Name	Description
P	The three types of products, High-Gloss, Semi-Gloss, and Flat

1.1.2 Parameters

Parameter Name	Description
$rawA_p$	The amount of raw ingredient A needed to produce product $p \in P$
$rawB_p$	The amount of raw ingredient B needed to produce product $p \in P$
$demand_p$	The minimum demand to be met for product $p \in P$
$profit_p$	The associated profit for product $p \in P$

1.1.3 Decision Variables

Variable Name	Description
$amtToProduce_p$	The amount of product $p \in P$ to produce and is ion the set of integers

1.1.4 Objective Function

$$maximize\ theProfit : \sum_{p} amtToProduce_p \times profit_p$$

1.1.5 Constraints

C1: Meet the minimum demand for each product

$$meetMinDemand : amtToProduce_p \geq demand_p, \ \forall \ p \in P$$

C2: Cannot exceed the supply of Raw Material A

$$rawSupplyA : \sum_p amtToProduce_p \times rawA_p \leq 4,000$$

C3: Cannot exceed the supply of Raw Material B

$$rawSupplyB : \sum_p amtToProduce_p \times rawB_p \leq 6,000$$

C4: Ratio of 3:2 for High and Semi Gloss, respectively

- Since $\frac{3}{2} = 1.5$, the amount of high gloss produced must always be $1.5\times$ semi gloss

$$highToSemiRatio : 1.5 \times amtToProduce_{Semi \in P} = amtToProduce_{High \in P}$$

C5: Non-Negativity Constraints and is Integer

$$amtToProduce \geq 0, \in \mathbb{Z}$$

1.2 Code and Output

1.2.1 Code

problem1.mod

```
# Daniel Carpenter
# Exam 1
# Problem 1

reset;                  # Reset globals
options solver cplex;   # Using cplex for simplex alg

# SETS ============================================================
    set P circular; # The three types of products, High-Gloss, Semi-Gloss,
    and Flat

# PARAMETERS ======================================================
    param  rawA   {P} >= 0; # Raw ingredient A needed to produce product p ∈
    P;
    param  rawB   {P} >= 0; # Raw ingredient B needed to produce product p ∈
    P;
    param  demand {P} >= 0; # Min demand to be met for product p ∈ P;
    param  profit {P} >= 0; # Associated profit for product p ∈ P;

# DECISION VARIABLES ==============================================
    var amtToProduce {P} >=0 integer; # amount of product p ∈ P to produce

# OBJECTIVE FUNCTION ==============================================
    maximize theProfit: sum{p in P} amtToProduce[p] * profit[p];

# CONSTRAINTS =====================================================

    # C1: Meet the minimum demand for each product
    s.t. meetMinDemand{p in P}: amtToProduce[p] >= demand[p];

    # C2/3: Cannot exceed the supply of Raw Material A or B
    s.t. rawSupplyA: sum{p in P} amtToProduce[p] * rawA[p] <= 4000;
    s.t. rawSupplyB: sum{p in P} amtToProduce[p] * rawB[p] <= 6000;

    # C4: Ratio of 3:2 for High and Semi Gloss, respectively
    s.t. highToSemiRatio {p in P}: 1.5 * amtToProduce[last(P)] ==
    amtToProduce[first(P)];

# CONTROLS ========================================================
    data problem1.dat;
    solve;

    print;
    print "For each product, product the following amounts:";
    display amtToProduce;
```

problem1.dat

```
# Daniel Carpenter
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# Problem 1

data;

# The three types of products, High-Gloss, Semi-Gloss, and Flat
set P := High Flat Semi;

#  rawA     The amount of raw ingredient A needed to produce product p ∈ P;
#  rawB     The amount of raw ingredient B needed to produce product p ∈ P;
#  demand   The minimum demand to be met for product p ∈ P;
#  profit   The associated profit for product p ∈ P;
param:
        rawA    rawB    demand  profit :=
    High    2       4       200     30
    Semi    3       2       200     20
    Flat    5       7       150     50
    ;
```

1.2.2 Output

- Not High to Semi is a 3:2 ratio and all demand and supply constraints are satisfied.

```
ampl: model 'C:\Users\daniel.carpenter\OneDrive - the Chickas
CPLEX 20.1.0.0: optimal integer solution; objective 42700
4 MIP simplex iterations
0 branch-and-bound nodes

For each product, product the following amounts:
amtToProduce [*] :=
High  810
Flat  152
Semi  540
;
```