Module 2: Assignment 1

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Part 1: Back Savers The decision variables are x_C, the weekly quantity of Collegiate model backpacks to produce, and x_M, the weekly quantity of Mini model backpacks to produce. The objective function is to maximize the profit $Z = 32x_C + 24x_M$. There are four constraints. The first two constraints come from each model having a maximum that can be sold per week: $x_C \leq 1000$ and $x_M \leq 1200$. Next, we have a limited number of materials that we can use, so $3x_C + 2x_M \leq 5000$. Finally, each product takes a certain amount of time to make, and we only have 35 laborers working 40 hours a week, for a total of 84000 minutes of labor per week, so $45x_C + 40x_M \leq 84000$.

The full mathematical formulation of the problem is as such:

MAX $Z = 32x_C + 24x_M$ subject to
$x_C \leq 1000$,
$x_M \leq 1200$,
$3x_C + 2x_M \leq 5000$,
$45x_C + 40x_M \leq 84000$, and
$x_C,\ x_M \geq 0$.

Part 2: Weigelt Corporation There are nine decision variables in play: one variable for each of large, medium, and small products, corresponding to each of the 3 plants. These variables are best visualized as a matrix:
$\mathbf{X} = \begin{pmatrix} x_{1,l} & x_{1,m} & x_{1,s} \\ x_{2,l} & x_{2,m} & x_{2,s} \\ x_{3,l} & x_{3,m} & x_{3,s} \end{pmatrix}$, where $x_{1,l}$ represents the number of large products to produce in plant 1, $x_{2,s}$ represents the number of small products to produce in plant 2, and so on.

The full mathematical formulation of this problem is as such:

MAX $Z = 420(x_{1,l} + x_{2,l} + x_{3,l}) + 360(x_{1,m} + x_{2,m} + x_{3,m}) + 300(x_{1,s} + x_{2,s} + x_{3,s})$ subject to
$20x_{1,l} + 15x_{1,m} + 12x_{1,s} \leq 13000$,
$20x_{2,l} + 15x_{2,m} + 12x_{2,s} \leq 12000$,
$20x_{3,l} + 15x_{3,m} + 12x_{3,s} \leq 5000$,
$x_{1,l} + x_{1,m} + x_{1,s} \leq 750$,
$x_{2,l} + x_{2,m} + x_{2,s} \leq 900$,
$x_{3,l} + x_{3,m} + x_{3,s} \leq 450$,
$900(x_{1,l} + x_{1,m} + x_{1,s}) = 750(x_{2,l} + x_{2,m} + x_{2,s})$,
$450(x_{1,l} + x_{1,m} + x_{1,s}) = 750(x_{3,l} + x_{3,m} + x_{3,s})$,
$x_{1,l} + x_{2,l} + x_{3,l} \leq 900$,
$x_{1,m} + x_{2,m} + x_{3,m} \leq 1200$,
$x_{1,s} + x_{2,s} + x_{3,s} \leq 750$, and
$x_{i,j} \geq 0$.