Classic LP Application Forms

Product Mix Model = determination of product combination to maximize profit.

Principal decision variables in product mix models specify how many units of each product should be produced.

Resource constraints in product mix models ensures that the allocation of critical resources used in the production process does not exceed available supplies.

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Allocation Models = how to divide or allocate a valuable resource among competing needs.

Principal decision variables in allocation models specify how much of the critical resource is allocated to each use.

Resource constraints in allocation models ensures that the allocation of critical resources to all uses does not exceed available supplies.

Performance constraints in allocation models ensures that critical resources are allocated in a manner which meets various performance criteria.

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Example 4.1: Forest Service Allocation (p. 132)

The allocation of forest land to maximize net present value of returns while meeting various land use demands.

Model Formulation:

$$\text{Max } Z = \sum_{i=1}^{7}\sum_{j=1}^{3} p_{ij}\, x_{ij} \qquad \text{(Net present value)}$$

s.t.

$$\sum_{j=1}^{3} x_{ij} = s_i \quad i = 1, \ldots 7 \qquad \text{(Allocation constraint)}$$

$$\sum_{i=1}^{7}\sum_{j=1}^{3} t_{ij}\, x_{ij} \geq 40{,}000 \qquad \text{(Timber)}$$

$$\sum_{i=1}^{7}\sum_{j=1}^{3} g_{ij}\, x_{ij} \geq 5 \qquad \text{(Grazing)}$$

$$\frac{1}{788}\sum_{i=1}^{7}\sum_{j=1}^{3} w_{ij}\, x_{ij} \geq 70 \qquad \text{(Wilderness)}$$

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Blending Models = how to mix ingredients into combinations which best fulfills specified output requirements

Principal decision variables in blending models specify how much of each available ingredient to include in the mix.

Composition constraints in blending models enforce upper and/or lower limits on the properties of the resulting blend.

Ratio constraints, which bound the quotient of linear functions by a constant, can often be converted to linear constraints by cross-multiplication. However, if the constraint is an inequality, the sign of the denominator function must be predictable over feasible solutions.

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Example 4.2: Swedish Steel (p. 135)

The blending of materials to produce steel alloys at a minimum cost with specific properties.

Model Formulation:

Min $Z = \sum_{i=1}^{7} c_i x_i$ (Cost)

s.t.

$\sum_{i=1}^{7} x_i = 1000$ (Weight constraint)

$\sum_{i=1}^{7} cl_i x_i \geq 0.0065\,(1000)$ (Carbon composition lower constraint)

$\sum_{i=1}^{7} cu_i x_i \leq 0.0075\,(1000)$ (Carbon composition upper constraint)

$\sum_{i=1}^{7} nl_i x_i \geq 0.0030\,(1000)$ (Nickel composition lower constraint)

$\sum_{i=1}^{7} nu_i x_i \leq 0.0035\,(1000)$ (Nickel composition upper constraint)

$\sum_{i=1}^{7} ml_i x_i \geq 0.0065\,(1000)$ (Molybdenum composition lower constraint)

$\sum_{i=1}^{7} mu_i x_i \leq 0.0075\,(1000)$ (Molybdenum composition upper constraint)

$x_1 \leq 75$ (Availability constraint)

$x_2 \leq 250$ (Availability constraint)

$\sum_{i=1}^{7} chl_i x_i \geq 0.0010\,(1000)$ (Chromium composition lower constraint)

$\sum_{i=1}^{7} chu_i x_i \leq 0.0012\,(1000)$ (Chromium composition upper constraint)