Modelling LP: A Blending Problem

A Blending Problem: The Agri-Pro Company

- Agri-Pro has received an order for 8,000 pounds of chicken feed to be mixed from the following feeds.

	Percent of Nutrient in			
Nutrient	Feed 1	Feed 2	Feed 3	Feed 4
Corn	30%	5%	20%	10%
Grain	10%	3%	15%	10%
Minerals	20%	20%	20%	30%
Cost per pound	$0.25	$0.30	$0.32	$0.15

- The order must contain at least 20% corn, 15% grain, and 15% minerals.

Defining the Decision Variables

X_1 = pounds of feed 1 to use in the mix

X_2 = pounds of feed 2 to use in the mix

X_3 = pounds of feed 3 to use in the mix

X_4 = pounds of feed 4 to use in the mix

Defining the Objective Function

Minimize the total cost of filling the order.

MIN: $0.25X_1 + 0.30X_2 + 0.32X_3 + 0.15X_4$

Defining the Constraints

- Produce 8,000 pounds of feed

  $X_1 + X_2 + X_3 + X_4 = 8,000$
- Mix consists of at least 20% corn

  $(0.3X_1 + 0.05X_2 + 0.2X_3 + 0.1X_4)/8000 >= 0.2$
- Mix consists of at least 15% grain

  $(0.1X_1 + 0.3X_2 + 0.15X_3 + 0.1X_4)/8000 >= 0.15$
- Mix consists of at least 15% minerals

  $(0.2X_1 + 0.2X_2 + 0.2X_3 + 0.3X_4)/8000 >= 0.15$
- Nonnegativity conditions

  $X_1, X_2, X_3, X_4 >= 0$

A Comment About Scaling

- Notice the coefficient for X_2 in the ‘corn’ constraint is 0.05/8000 = 0.00000625
- As Solver runs, intermediate calculations are made that make coefficients larger or smaller.
- Storage problems may force the computer to use approximations of the actual numbers.
- Such ‘scaling’ problems sometimes prevents Solver from being able to solve the problem accurately.
- Most problems can be formulated in a way to minimize scaling errors...

Re-Defining the Decision Variables

X_1 = ***thousands of pounds*** of feed 1 to use in the mix

X_2 = ***thousands of pounds*** of feed 2 to use in the mix

X_3 = ***thousands of pounds*** of feed 3 to use in the mix

X_4 = ***thousands of pounds*** of feed 4 to use in the mix

Re-Defining the Objective Function

Minimize the total cost of filling the order.

$$\text{MIN:} \quad 250X_1 + 300X_2 + 320X_3 + 150X_4$$

Re-Defining the Constraints

- Produce 8,000 pounds of feed

  $X_1 + X_2 + X_3 + X_4 = 8$

- Mix consists of at least 20% corn

  $(0.3X_1 + 0.05X_2 + 0.2X_3 + 0.1X_4)/8 >= 0.2$

- Mix consists of at least 15% grain

  $(0.1X_1 + 0.3X_2 + 0.15X_3 + 0.1X_4)/8 >= 0.15$

- Mix consists of at least 15% minerals

  $(0.2X_1 + 0.2X_2 + 0.2X_3 + 0.3X_4)/8 >= 0.15$

- Nonnegativity conditions

  $X_1, X_2, X_3, X_4 >= 0$

Scaling: Before and After

- Before:
  - Largest constraint coefficient was 8,000
  - Smallest constraint coefficient was 0.05/8,000 = 0.00000625.
- After:
  - Largest constraint coefficient is 8
  - Smallest constraint coefficient is 0.05/8 = 0.00625.
- The problem is now more evenly scaled!

The Assume Linear Model Option

		Agri-Pro				
	Feed 1	Feed 2	Feed 3	Feed 4	Total	
Unit cost	$250	$300	$320	$150	$1,950	Units Req'd
Units to mix	4.5	2.0	0.0	1.5	8	8
(Note: 1 unit = 1,000 pounds)						
	Percent of Nutrient in				Amount	Minimum
Nutrient	Feed 1	Feed 2	Feed 3	Feed 4	in Blend	Req'd Amnt
Corn	0.30	0.05	0.20	0.10	20.00%	20.0%
Grain	0.10	0.30	0.15	0.10	15.00%	15.0%
Minerals	0.20	0.20	0.20	0.30	21.88%	15.0%