ISYE 3133 Project Phase 1 Deliverable

Nathan Cung, Eashan Gandotra, and Malina Hy

10/29/2021

Notes

- The indices of animal, food type, and facility are the indices of the table in the provided data set - $i, j, k \forall i \in [1:3], j \in [1:20], k \in [1:9]$.

- The model requires that recommended food value be assigned to individual animals before the model is run - for example, child animals will be assigned the child food recommended intake, and adult animals will be assigned the adult food recommended intake, based on the adulthood age of the animal's species.

- We assume there are 90 days/3 months in one fiscal quarter.

Data / Parameters

$$c_{ij} = \text{cost per pound of food type } j \text{ for animal } i$$
$$w_{ij} = \text{welfare score for food type } j \text{ for animal } i$$
$$q_k = \text{estimated monthly attendance increase per 10,000 dollar investment in facility } k$$
$$r_i = \text{pounds of food required per day by animal } i$$

Variables

$$x_{ij} = \text{daily number of pounds of food type } j \text{ for animal } i$$
$$a_k = \text{dollars invested in facility } k$$

Model

$$\max z = \sum_{k=1}^{9} a_k + \sum_{i=1}^{20} \frac{1}{x_{i,1} + x_{i,2} + x_{i,3}} \sum_{j=1}^{3} x_{i,j} w_{i,j}$$

s.t.

$$a_k \leq 20,000 \forall i$$

$$200000 + 10(\sum_{k=1}^{9} \frac{3q_k}{10000}) \geq 1.05(100000 + \sum_{k=1}^{9} a_k + \sum_{i=1}^{20} \sum_{j=1}^{3} \frac{90 x_{ij} c_{ij}}{10})$$

$$\sum_{j=1}^{3} x_{ij} = r_i \forall i$$

$$x_{ij}, a_k \geq 0 \forall i, j, k$$

Derviation of revenue and cost constraint

$$\text{revenue} = 200000 + 10\left(\sum_{k=1}^{9} \frac{3q_k}{10000}\right)$$

$$\text{costs} = 100000 + \sum_{k=1}^{9} a_k + \sum_{i=1}^{20}\sum_{j=1}^{3} \frac{90x_{ij}c_{ij}}{10}$$

$$\text{revenue} \geq 1.05(\text{costs})$$

$$200000 + 10\left(\sum_{k=1}^{9} \frac{3q_k}{10000}\right) \geq 1.05\left(100000 + \sum_{k=1}^{9} a_k + \sum_{i=1}^{20}\sum_{j=1}^{3} \frac{90x_{ij}c_{ij}}{10}\right)$$