ISYE 3133 Fall 2021
Project Part 1

This project will have 4 parts, each worth 25 points. In Part 1, you will write an LP model. In future parts, you will implement the model with gurobipy, and incorporate integer programming into your model and implementation. You are encouraged to complete Part 1 with implementing your Part 1 model in mind. If your Part 1 model is incorrect, you are permitted to resubmit your model in Part 2 to earn back up to half of the lost points.

Your team is working for a nature reserve. You've been given two main goals this quarter:

1. Improving animal welfare through more efficient choice of animal feed; and
2. Improving the guest experience at the reserve to promote attendance.

After investigating options with suppliers, testing samples, surveying guests and residents of your state, and speaking with keepers, your team has gathered the following information.

For each of the reserve's N animal species, you have identified three food options, and the cost of 10 pounds of food for each species. As a simplifying assumption, assume that each animal of a species receives the same mix of food as the others of its species. Foods can be mixed, so long as each animal receives no more or less food than its recommended calorie intake.

Your expert keepers have assigned each food type a welfare value, from 1 to 10, based on how well it fits each animal's needs (the lowest for a given species need not be 1, and the highest need not be 10). Since this quarter's focus is on food, each animal's welfare score can be represented by the average welfare value of the food it eats.

Your keepers have also given you their information on each of the reserve's animals, including their names and respective ages and species. Young animals and adult animals have different food needs, so the keepers have given you each animal species's food requirements for young and for adults separately.

The reserve currently has average quarterly costs (excluding animal food) of \$100,000 and an average quarterly revenue of \$200,000. Your team may choose to invest up to \$20,000 each into any facilities that you determine to be important. There are several facilities that you could invest in, in different ways–an investment into restrooms, for example, could represent a remodeling, and an investment into gift shops could represent the development of new merchandise. Any investment into the opportunities your team has identified is expected to improve the guest experience and lead to improved attendance. By surveying both reserve guests and non-reserve-guests, your team has estimated the improved attendance that could result from investing into each opportunity. Your team expects an average increase in revenue of \$10 for each new guest brought into the reserve.

While there is no direct limit on your spending, you are expected to maintain at least a 5% profit margin; that is, your total expected revenues should be no less than 1.05 times your total expected costs.

Write an LP to maximize average animal welfare scores across the entire reserve, while maintaining the expected profit margin. The results of your team's investigation into the scenario are in the included spreadsheet–no other data is available to you at this time.

Your submission for this part of the project should consist of three written sections:

- Data: This section should include definitions for all parameters you use in your model. No variables should be defined in this section.

- Variables: This section should include definitions for all variables you use in your model. No parameters should be defined in this section.
- Model: Your LP model for the given situation.