**Operations Research Fall 2022**

**Community-Engaged Learning Case Study Project**

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**Allocating Space and Money for Southwestern University (SU) Library and Special Collections**

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[The Bad Boys Book Club]

**Context:**

In recent conversations with SU faculty, we have learned that the A Frank Smith, Jr. Library Center has parts of the building's foundation that are sinking. The university has planned reconstruction for these parts. These areas are made up of the Special Collections and neighboring parts of the library that are used to house books, shelves, periodicals, and other various artifacts that were donated to the library. All these items need to be moved into storage; some need climate-controlled storage and elevated security features. Unfortunately, due to other projects, the campus storage is being used at the time of construction. While there are certain rooms in the library that can house parts of special collections for the renovations, the library is still tasked with finding other storage locations during reconstruction, including storage that is climate controlled.

This course has now given us the opportunity to aid the library to help search for solutions to the storage dilemma; while considering the most efficient way for the school to save money and storage. Our goal will be to give a few possible solutions that can offer the most space and safety of the items for different prices; while choosing what we believe to be the most optimal solution.

**Motivation:**

The Library seeks to minimize the cost and space associated with storing items in special collections. We will strive to find an optimal solution for both within our limited time constraint. It is important to keep special collections safe while not wasting any money.

**Stakeholders:**

The relevant stakeholders for optimizing the storage of Special Collections are the donors of special collections, the board of directors and trustees at SU, the faculty and staff, and any students or visitors interested in seeing Special Collections.

**Trade-offs:**

The stakeholders aim to safely store special collections while keeping the cost to a minimum. In order to properly store certain items safely, some options will cost more money.The university has limited on-campus storage, and while they aren’t necessarily limited on money, we still aim to go with the cheapest option.

**Methodology**

**Simplifying Assumptions:**

Many of our values will need to be integers, as we can’t put partial books into boxes, nor can we put partial boxes into storage units. However, we would be able to use fractional values of spaces used for storage. All sizes and dimensions for items will be done in inches, and any weights are in pounds.

**Variables:**

This task will need to be broken up into two distinct programs. The first is minimizing the number of storage boxes needed for storing special collections. The second is minimizing the cost and/or space required to keep special collections once most of it has been sorted into boxes.

Part 1: Sorting Special collections into boxes:

1. The size of a book
2. The weight of a book
3. The size of any objects that aren’t books, but still fit in a box
4. The weight of any objects that aren’t books, but still fit in a box
5. The size of any objects too large for a box
6. The weight of any objects too large for a box

Part 2: Storing the boxes

1. The number of boxes, will be an integer
2. Any additional items that do not fit in the boxes. This may come down to gathering all of the weights and volumes.
3. Integer programming for free rooms
4. The cost to rent non-environmentally controlled storage
5. The cost to rest environmentally controlled storage

**Parameters:**

For the first portion, putting special collections into boxes, we need to minimize the number of boxes used, which means packing as many as close to 40 lbs without going over. The number of boxes will have to be an integer when storing boxes. We also need to be able to apply integer programming to each available room to toggle whether or not it is available or if it is optimal to use. All variables will also have to be non-negative.

**Data Collection:**

* Acquire the constraints needed for the project. This may include the size of storage rooms, units, 40 lbs box limit.
* Find consistent measurements for storing the books in boxes. We’ve talked about taking averages, or using the shelf heights to our advantage. It is infeasible to measure all of the books individually, so using some sort of average system like this is necessary. We will try several methods, and go with the most reasonable for collecting the data.
* Communicate with Megan on more details about storage unit options, and other options for storing on campus.
* Other forms of data may need to be collected, at this time tape measures are provided, but a scale may be needed.

**Preliminary Plan:**

Once data collection is complete, we plan to solve this equation in GLPSOL using the simplex method. Our objective function will either focus on minimizing cost or space needed. We believe that these two parameters will be interconnected in some way, but we will go with the solution that is deemed most beneficial for storing special collections. Finally, we plan to give the library our GLPSOL program and show them how to use it, so they can see the differences and add new options to the program in the event more or fewer rooms become available or a different storage company is found.

**Possible Computational Issues:**

Making sure that everything that needs to be climate controlled gets put into the correct storage may be challenging. In addition, working with integer programming may be difficult mixed in with making sure certain variables are integers, and others not having such constraints. We are using GLPSOL because we are aware there will be a lot of variables that need to be accounted for. We will make sure we take extra precautions to make sure that we don’t make any mistakes.

**Honor Code:** We have acted with honesty and integrity in producing this work and am unaware of anyone who has not.

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