GBA468 – Assignment 1
Due Monday, 2/2 @ 11:59 PM ET

Please submit your work in a well-commented Jupyter Notebook with your output generated.  You may submit 1 file or 3 separate files, one for each question.  The easier it is for us to find your answers and follow your work, the better we can grade/award partial credit.

1.        In the undergraduate honors program at PNU, students bid for internships in the final year of their program.  Each student has 100 total points to bid.  They can allocate these points across the different options to indicate their preferences (for example, a student who really wanted to be assigned to the Innova internship might put 80 out of their 100 points in that column).  Students complete exactly two different internships (i.e., a student may not do the same internship twice).  Each internship is limited to 5 students.  The seven internships available are shown in Table 1 along with the point "bids" submitted by each of the 15 students in the program.

The bids submitted by each of the 15 students in the program for the seven available internships are contained in the data file HW1_BidData.csv.

Build a model that can be used to assign students to internships in order to maximize the total bid points for all students given their assignments.  Solve the model to determine which internship assignments each student receives in the optimal solution.

2.    The Molokai Nut Company (MNC) makes four different products from macadamia nuts grown in the Hawaiian Islands: chocolate-coated whole nuts (Whole), chocolate-coated nut clusters (Cluster), chocolate-coated nut crunch bars (Crunch) and plain roasted nuts (Roasted).

To meet marketing demands for the coming week, MNC needs to produce at least 1,000 pounds of the Whole product, between 400 and 500 pounds of the Cluster product, no more than 150 pounds of the Crunch product and no more than 200 pounds of the Roasted product.

Each pound of the Whole, Cluster, Crunch and Roasted product contains, respectively, 60%, 40%, 20% and 100% macadamia nuts with the remaining weight made up of chocolate coating. The company has 1100 pounds of nuts and 800 pounds of chocolate available for use in the next week.

The various products are made using four different machines that hull the nuts, roast the nuts, coat the nuts in chocolate, and package the products. Table 1 summarizes the time required in minutes for each product on each machine. Each machine has 60 hours of production time available in the coming week.

**Table 1: Machine Minutes Required per Pound**

| Machine | Whole | Cluster | Crunch | Roasted |
|---|---|---|---|---|
| Hulling | 1.00 | 1.00 | 1.00 | 1.00 |
| Roasting | 2.00 | 1.50 | 1.00 | 4.00 |
| Coating | 1.00 | 0.70 | 0.20 | 0 |
| Packaging | 2.50 | 1.60 | 1.25 | 1.00 |

The company's controller recently presented management with a financial summary of MNC's average weekly operations over the past quarter. The Variable Margin per pound for each of the products is shown below.

| Product | VM/lb |
|---|---|
| Whole | $1.93 |
| Cluster | $1.04 |
| Crunch | $1.15 |
| Roasted | $1.33 |

A.    Build a linear programming model to identify the production levels for MNC's four products that maximize total VM.

B.    If MNC wanted to decrease the production of any product, which product would you recommend and why?

C.    Which machine capacities would you recommend the company look into expanding? If they can only expand one machine capacity, which machine should they target?

3.      A movie production company will be shooting on location in Atlanta, GA for five months. During this time period, the production company will require storage space for its sets, props and costumes, which it can lease from a local warehouse. The warehouse leases storage space by the square foot at prices shown in Table 1 below.  The price varies by the duration of the lease.  For example, a 3-month lease costs $135 per square foot.  This $135 is a fixed rate for all 3 months of the lease (in other words, it is not $135 per month).

**Table 1:  Lease Cost by Lease Duration**

| Cost per sq. ft. | Lease Duration |
|---|---|
| $ 65 | 1 month |
| $ 100 | 2 months |
| $ 135 | 3 months |
| $ 160 | 4 months |
| $ 190 | 5 months |

The warehouse will allow the production company to have multiple leases for space in any particular month and to lease space starting in any month for any duration. For example, the production company could sign a 3 month lease for 30,000 sq ft in month 1 and then add 1 month lease for an additional 20,000 sq ft in month 3.

The production company has varying needs for storage space over the course of the five month shoot. The space they estimate they will need in each month is shown in Table 2.

**Table 2: Space Required by Month**

| Month | Sq. Ft. |
|---|---|
| 1 | 30,000 |
| 2 | 20,000 |
| 3 | 40,000 |
| 4 | 10,000 |
| 5 | 50,000 |

Formulate and solve a LP model to determine the optimal leasing plan for the production company, in order to have all the storage space it needs in each month at the minimum cost.