Inventory Project

Rippy, Pat

March 30th, 2020

Introduction

We will be modeling a inventory management system, where we are selling a product. We can hold a specific number of product inventory, order inventory, and it will take place over a specific time interval. We will be using the model to find our maximal average net worth over a specific time interval. We will have a 'timeline' of processes, updating at discreet events, like ordering inventory or a customer buying inventory.

Model Approach

Our General Assumptions are as follows:

- Customers arrive according to a Homogenous Poisson Process at an average of 8 per day and place an order of between 1 and 12 items (uniformly random).
- Initially we have 100 items in stock and none on order. The maximum amount of product we can store is 100 items.
- Ordering new product costs \$1.00 per item and each new order from the factory includes a \$5.00 shipping fee, regardless of the order size. It takes 2 days to receive a new order. The reordering threshold is denoted as s. This is the inventory we must be below or equal to in order to place an order.
- The resale price of each item is \$2.50.
- The simulation period is 30 days.
- Holding costs are \$0.05 per item per day

With the general model assumptions, we found that a reordering stock of about 25 gives us a approximate best expected Net Worth $\approx$ \$1212.

All iterations of the model inherit these same general assumptions unless stated otherwise, in addition to a few other modifications.

```
In[39]:= data = Table[avgNW[n], {n, 1, 100, 1}];
         ListPlot[data]
```

Out[40]=

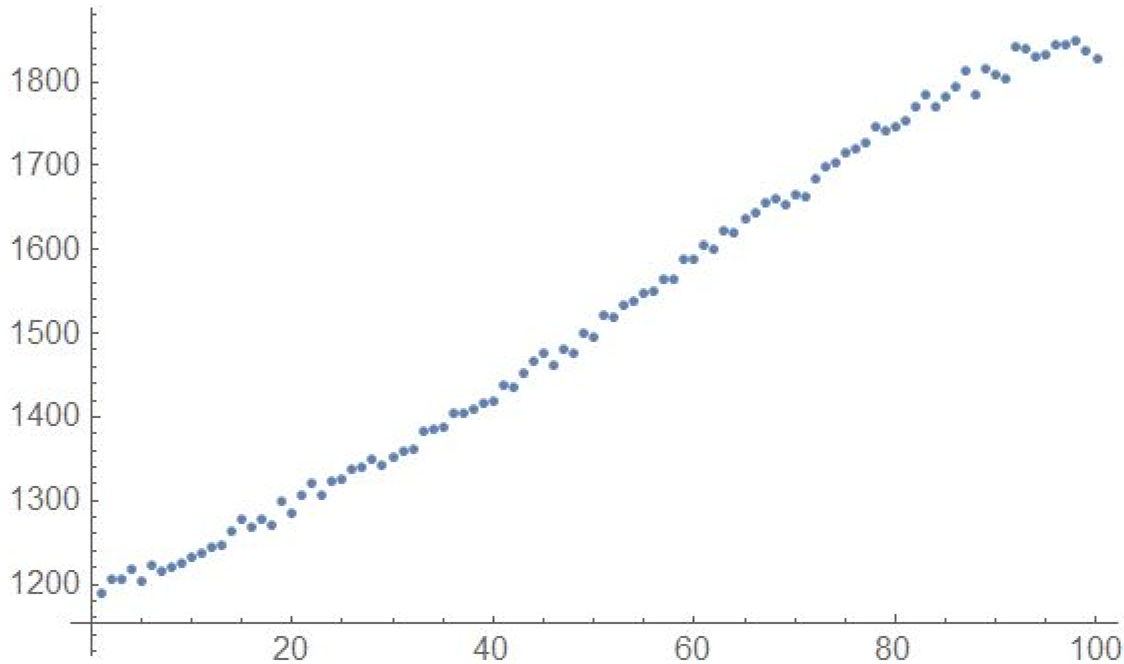

Figure 1: A graph of Average Net Worth vs. 's'

Model A

Additional Assumption: Instead of ordering S - x items when the inventory drops below s, we could choose to order up to S items. But since we don't have the place to store items above S, we'd have a loss of any items in excess of the total capacity (i.e., extra items get thrown away, but we have to pay for them anyway).

In this model, we find that the maximum average net worth $\approx \$1864$, for $s \approx 97$. This is a definite improvement over the basic assumptions.

Model B

Additional Assumption: Suppose we have the option of increasing the maximum amount of stock from 100 items to 200 items. This additional storage is more expensive, however. Holding costs are \$0.05 per item per day for 0-100 items, and each item from 101-200 costs \$0.10 per item per day.

.

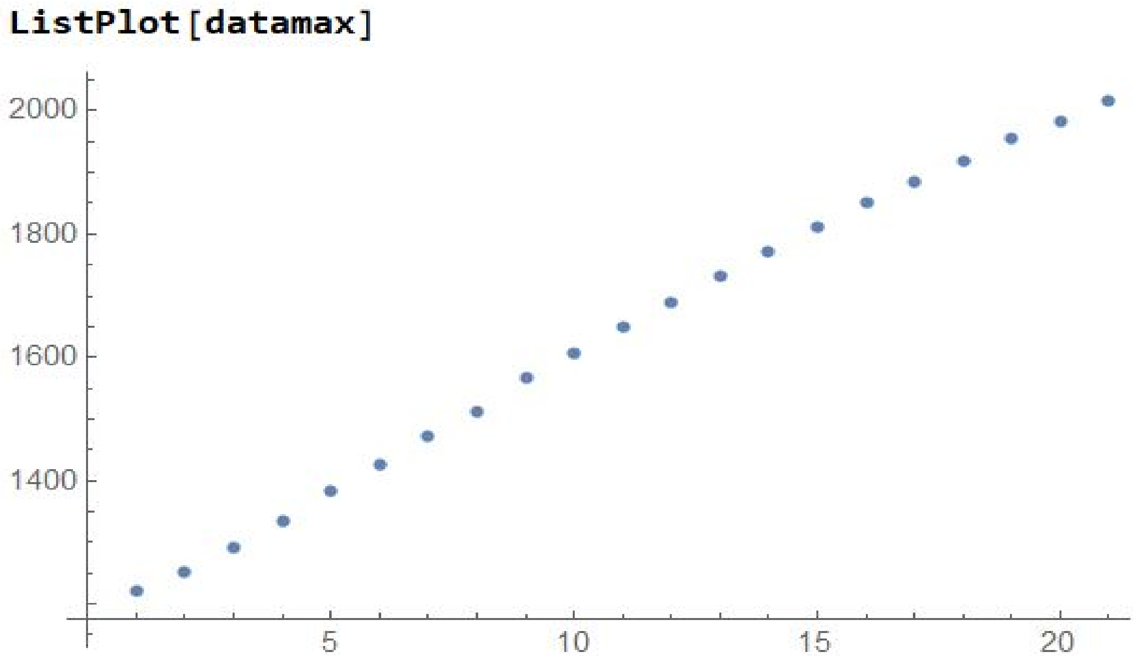

Figure 2: A Graph of Max Average net worth vs. Max inventory size *Note, though the s-axis is 0-20, this is actually 100-200, in increments of 5

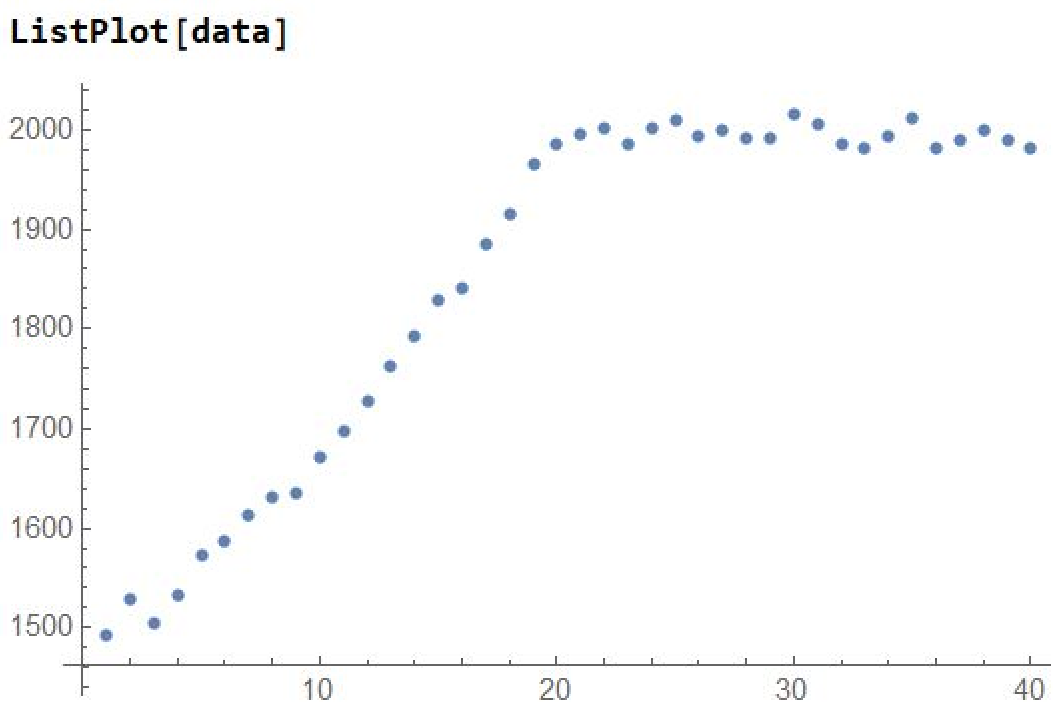

Figure 3: Average net worth for a maximum inventory of 200 vs. 's', *Note, though the s-axis is 0-40, this is actually 0-200, in increments of 5

```
data = Table[avgNW[n], {n, 0, 100, 1}];
ListPlot[data]
```

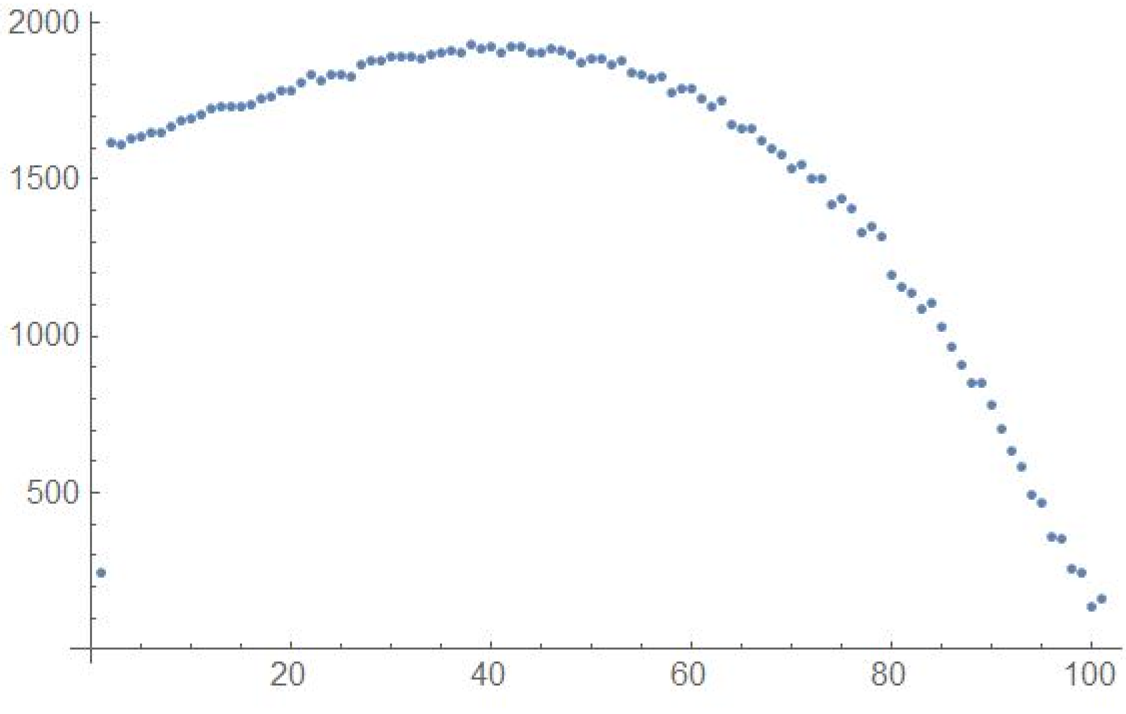

Figure 4: Average Net worth vs. 's'

It is evident by the graph, as we increase maximum inventory, our maximum average net worth increases accordingly. So, for the maximum inventory of 200, we have a maximal net worth of $\approx$ \$2010 at $s \approx 98$.

Model C

Now suppose we have the option of ordering new stock with expedited shipping at \$10 per order, regardless of order size, but it takes between 12-24 hours to receive the order (uniformly distributed).

It is evident by the graph, as 's' increases, it peaks, then quickly dips. It would not be a good idea to order expedited shipping when you are near capacity. The maximum average net worth $\approx$ \$1942, at $s \approx 40$

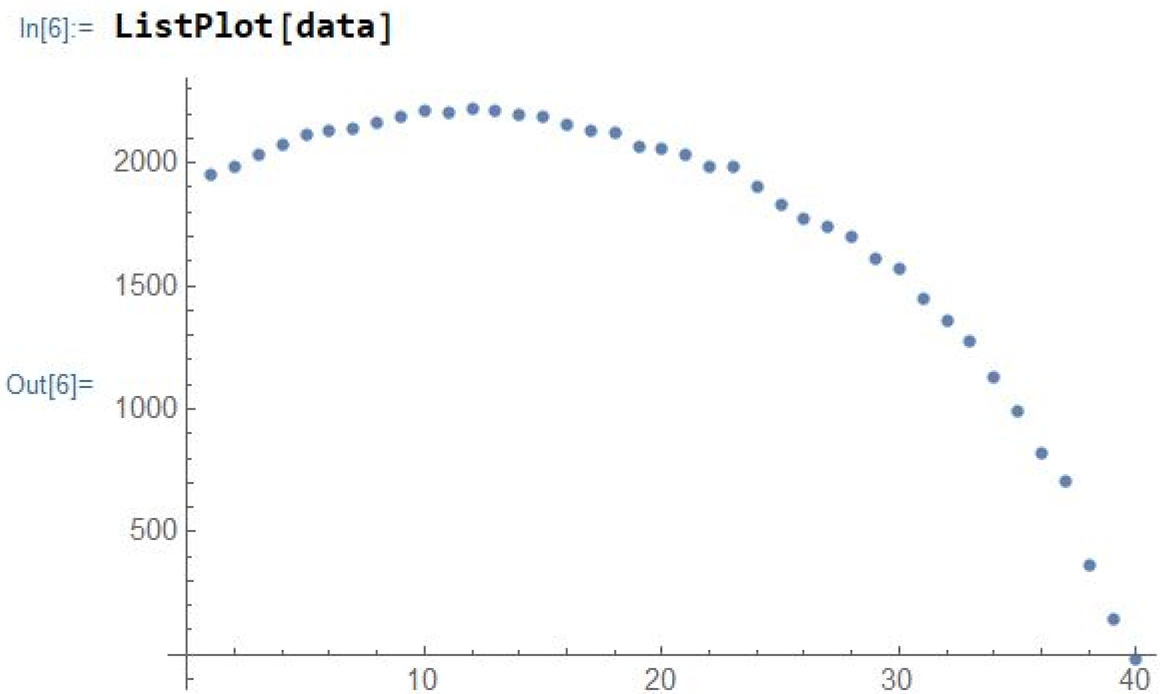

Figure 5: Average net worth vs. 's' *Note, though the s-axis is 0-40, this is actually 0-200, in increments of 5

Hybrid Model

In this hybrid model, we mix the ideas from the previous models A,B, and C. Our reordering threshold is s, and we order $S - \frac{s}{2}$, where S is our maximal inventory (from A). We increased the maximum inventory to 200 units (from B). Finally, we also use expedited shipping. (from C).

Based on our data simulations, we found the maximum average net worth of this hybrid model to be $\$2200.63 \pm 1.03\$$ (95% CI)

Results

Each model, A, B, and C increase the maximum net worth from the original vanilla model. In our hybrid model, we found a recording strategy of $s \approx 66$ worked the best, and ordering 167 units ($S - \frac{s}{2}$) was optimal. We found that increasing the maximum stock to 200 also increased the overall net worth. We also found expedited shipping helped increase our worth as well, however, it begin to dip net worth significantly as s increases, it should only be used for s values that are low.s

Conclusion

By combining the three ideas of changing reordering strategy, increasing inventory space, and implementing expedited shipping, we were able to run the business in a way that increased overall net worth more than the three options individually. With our best model, we can expect the business to have a net worth between \$2199.60 - \$2201.66 each month with 95% confidence. This figure is far superior to the original business model, which we found to have net worth around \$1212 each month. This is also an increase from the expected net worth of the other options individually; about \$1864 for changing reordering strategy, about \$2010 for increasing inventory space, and about \$1940 for implementing expedited shipping. From the values given here, our model shows an increase in net worth by 9.48% from increasing inventory size, 13.43% from using expedited shipping, 18.06% from changing the reordering strategy, and a staggering 81.57% from the original business model. Based on this data, we suggest the manager begin implementing our strategy as early as possible to begin maximizing profits and continuing to grow his business.