Instructions: In this lab, we will use Python to model and analyze costs associated with inventory.

You are required to work on your own and submit a report on lab notebook. Upload all your .py files on Moodle.

Exercise 1 How much to stock?
Akbar is in charge of running a milk supply depot. Every night he must decide how much milk should be packed and kept ready for delivery. The cost of milk is ₹32 per liter. In the morning, he sees the actual milk orders. The milk is sold at a fixed price of ₹38 per liter. Any milk that is left unsold at the end of the day can be sold to Bindu Sweets (for making dairy sweets) at a discounted price of ₹30 per liter. Akbar has a list of demands for last 500 days, and he wants to analyze it to make a decision of how much milk to keep in stock for delivery.

(a) **[R]** The demand of milk in last 500 days is available in milk.txt file on Moodle. Using this file, report the mean and standard deviation of demand. Plot the demand as a function of time. Also plot the demand using a histogram to see its distribution.

(b) **[R]** Suppose Akbar wants to know his expected profit if he packs 1000L. Using the past data find the average profit he would have made for this quantity.

(c) Suppose now Akbar wants to know how his expected profit would change with the quantity of his stock. Find the profit for several different stock quantities and plot the relation between the quantity and profit. Upload the plot to moodle.

(d) **[R]** Report what is the recommended stock level.

Exercise 2 Multistage Inventory

The sales network of the Mumbai division of Bindu Electronics operates a very simple supply chain for distributing television sets. There is only one store that sells the product. The store recieves products in batches from the warehouse, which gets its supply from a distribution center which in turn gets its supply from an assembly center. The company stores inventory of the products at all four locations. As the OR specialist in the company, you are asked to analyse and improve the stocking policy. The cost of holding inventory is ₹100 per week per tv at the store, ₹80 at the warehouse, ₹60 at the distribution center and ₹50 at the assembly center. If the store is unable to meet the demand, the customer is waitlisted and is given the TV set when the new stock arrives. The company loses ₹110 (in lost opportunity and reputation) per week per customer that is waitlisted. It takes 1 week for stocks to reach the store from the warehouse after it places an order. Similarly the lead time for getting new stock is 1 week at the warehouse and 2 weeks at the distribution center. For simplicity, you may assume that all demands and processing of orders takes place at the beginning of the week. Assume that each link has a starting inventory of 5000 units.

(a) [**R**] Suppose the weekly demand at the store for past 100 weeks is available on Moodle in the file tv.txt. Further suppose each link in the supply chain orders a fixed quantity of 5000 units from its supplier. Calculate the total cost of inventory and back-ordering for these 100 weeks. Plot the inventory levels at the four links in the chain in these 100 weeks if this policy is followed.

(b) [**R**] Changing the amount of this fixed quantity (but still keeping it constant over the weeks and the links of the chain) and evaluating the cost, find the best fixed-order quantity.

(c) [**R**] Now suppose that instead of ordering fixed quantity every month, each link in the chain wants to maintain a fixed stock in inventory, and places orders every week so to maintain it. Plot the inventory levels at the four links in the chain in these 100 weeks if this policy is followed. Assume that the target stock is 5000 at each link.

(d) [**R**] Is it reasonable to devise a stocking policy on this data? What can be done to make this decision-making more robust?

(e) [**R**] Try a policy of your choice which is different from the above two. Make relevant plots, report the cost incurred and comment on your policy.