

# Assignment STAT702

## 1 Analysis of Sales Data

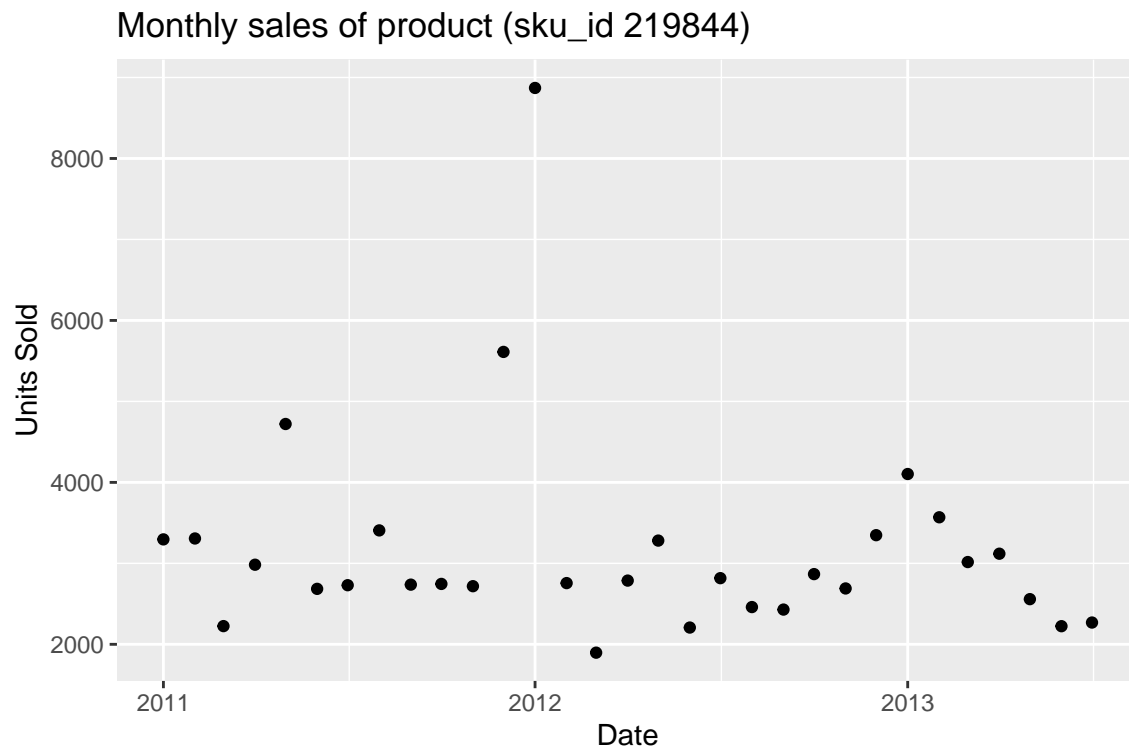
Product name: BIC Round Stic Xtra Life Ballpoint Pen, Medium Point (1.0mm), Red, 12-Count Sales  
sku\_id: 219884 Reviews asin: B00006IE7J

**1(a) For the product (sku\_id) which has been assigned to your group (see page 6), compute the total monthly sales from January 2011 – September 2013. Present your results in an appropriate plot and write 2 – 3 sentences describing your results.**

Hint: This will require some “wrangling” of the variable week. To do this, format week as a date and then use the appropriate lubridate function to extract the month.

Marking Criteria

- Total monthly sales have been correctly computed and are displayed in an appropriate plot.
- Description of results/plot is correct and provides useful insights.
- Plot is constructed using ggplot2 and has appropriate titles, labels, scales etc.



##	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
##	1897	2622	2787	3175	3302	8871

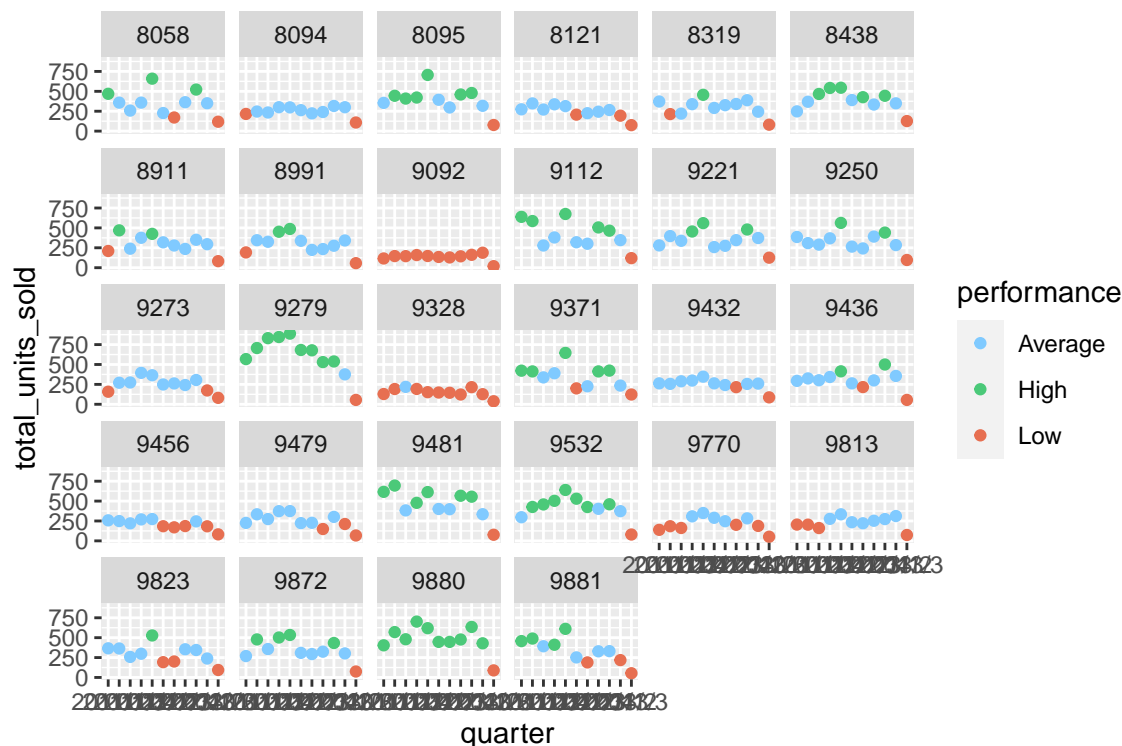
Mean monthly sales are 3175. Outlier of 8871 sales in Jan 2012, minimum observation is 1897 in March 2012. 50% of observations lie between the values 2622 (first quartile) and 3302 (third quartile). No seasonal variation or trend identified.

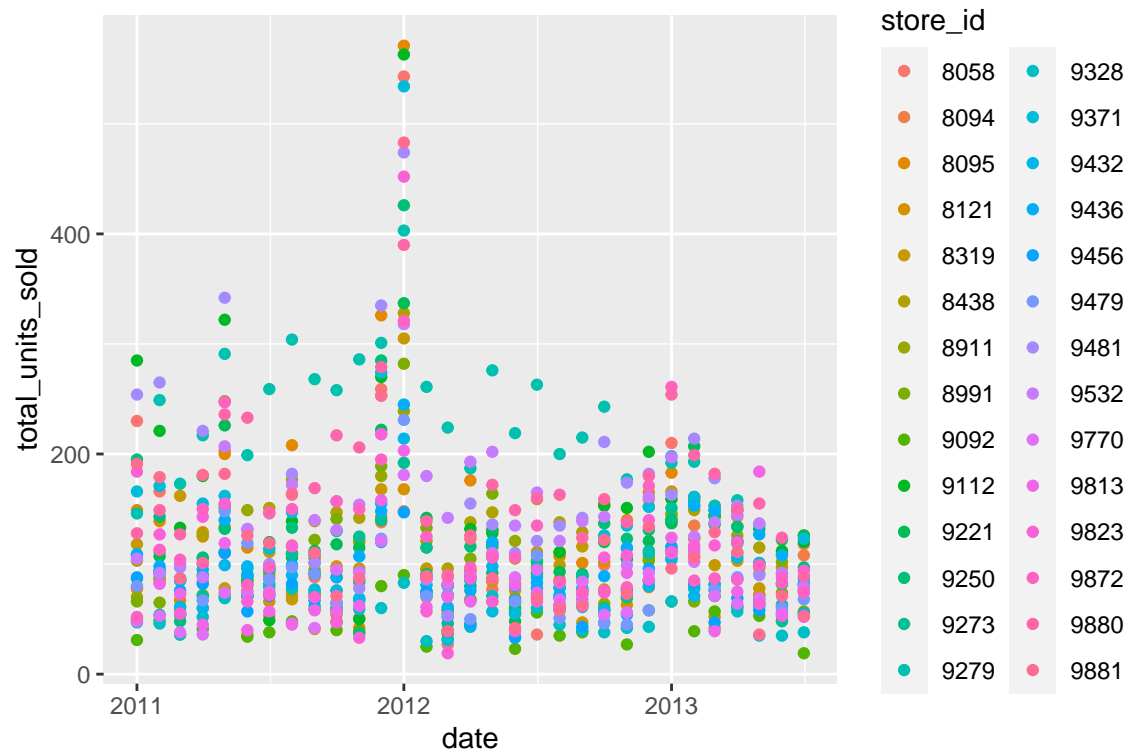
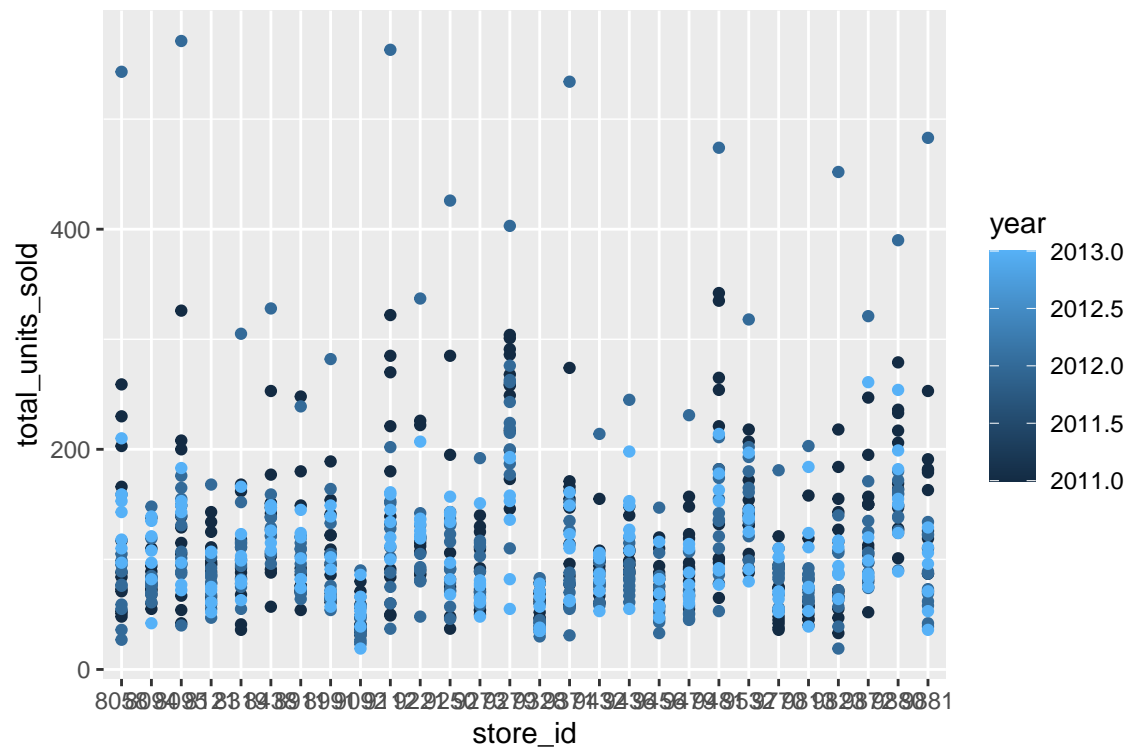
**1(b) The GM Sales wants to know which stores are performing well and which are not, in terms of product sales. For the product (sku\_id) which has been assigned to your group, use appropriate summary statistics and plots to investigate sales performance across the stores and write 2 – 3 paragraphs summarising your findings.**

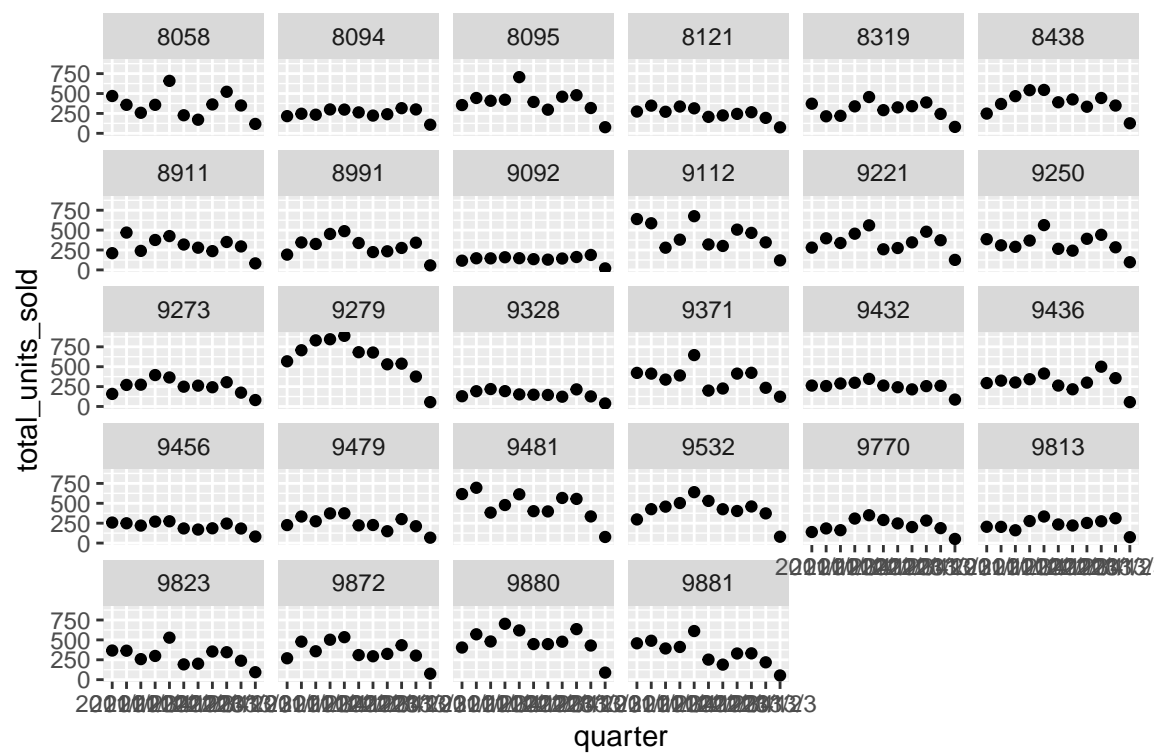
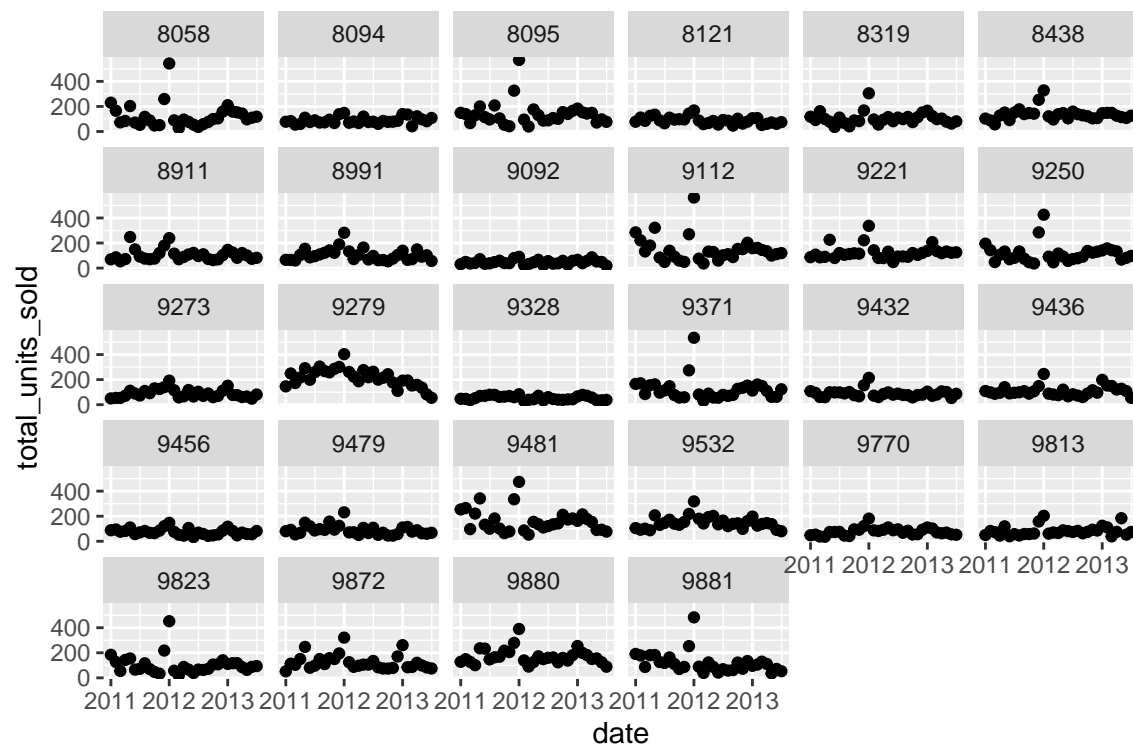
Hint: You will need to decide what it means for a store to be “performing well” and how you will evaluate this using the data.

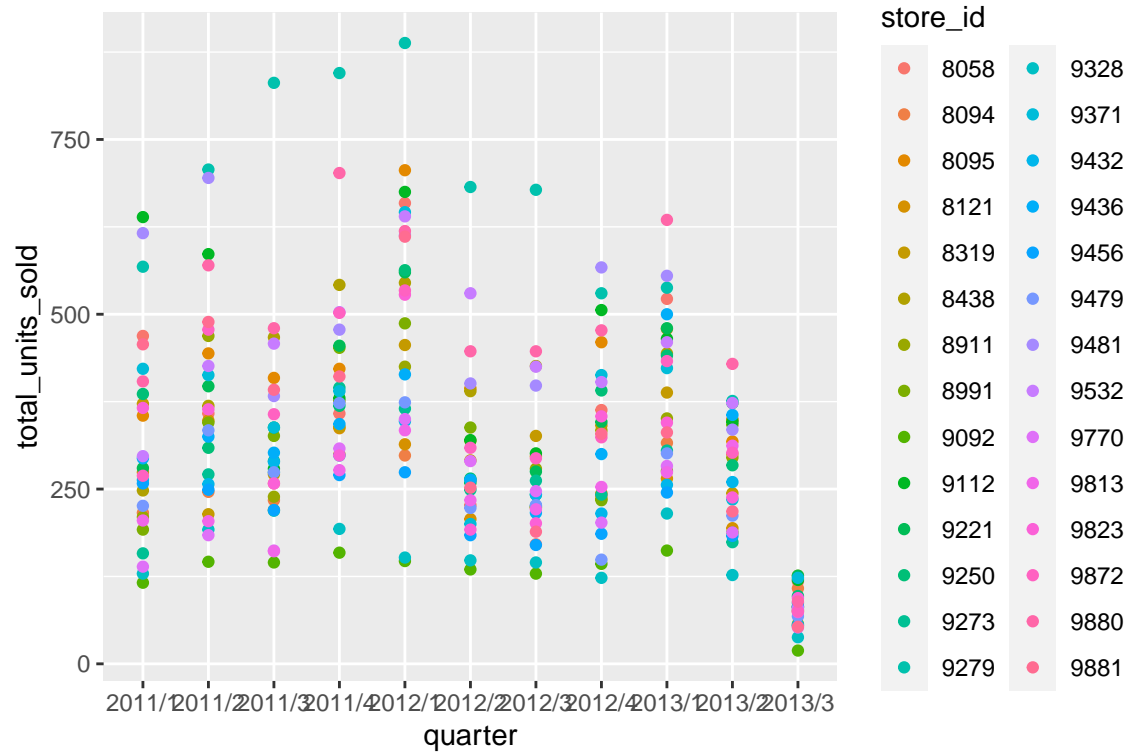
Marking criteria

- Sales performance is clearly defined.
- Written summary includes relevant and appropriate summary statistics and plots.
- Plot/s are constructed using ggplot2 and have appropriate titles, labels, scales etc.
- Descriptions of results and plots are correct and provides useful insights.







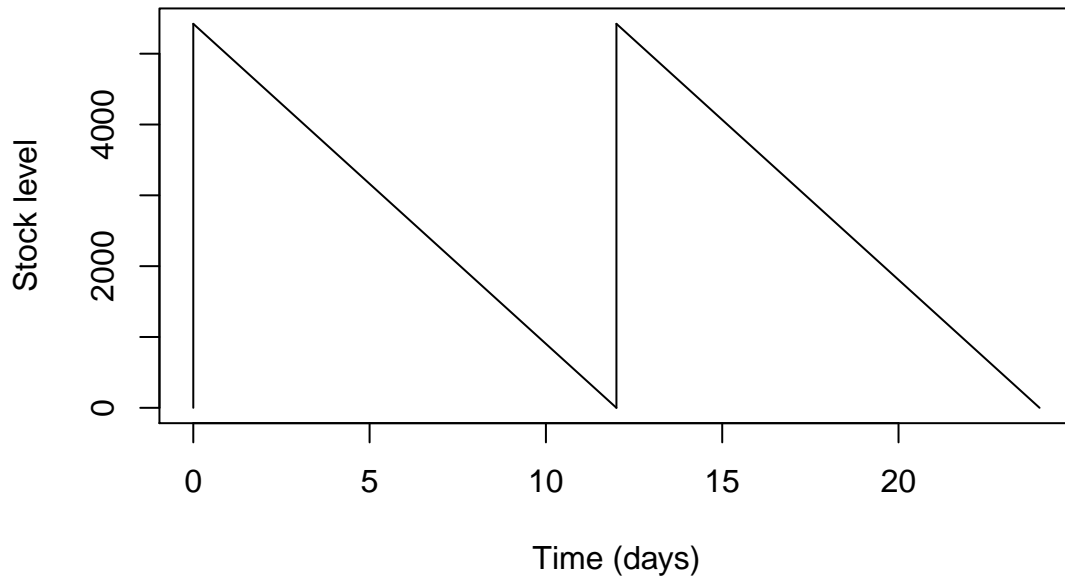


## Question 2

- (a) The Operations Manager is interested in studying an EOQ model for product 216233, based on sales in 2012. The setup and holding costs are known to be 130 per order and 1.50 per unit per year, respectively.
- i) Determine the best order quantity in such a way that the costs are minimised. Write 1 – 2 paragraphs summarising your findings.

Marking criteria • Number of orders during a year, number of days between orders, and the total annual inventory cost are correctly computed and included in the findings. • The paragraphs clearly explain your findings. • Assumptions of the EOQ model are clearly stated

## Inventory cycles for 216233



Optimum order quantity is 5422

Inventory cycle is 12

Annual inventory cost is 8132.6803762

Assumptions of EOQ model:

Known and constant demand

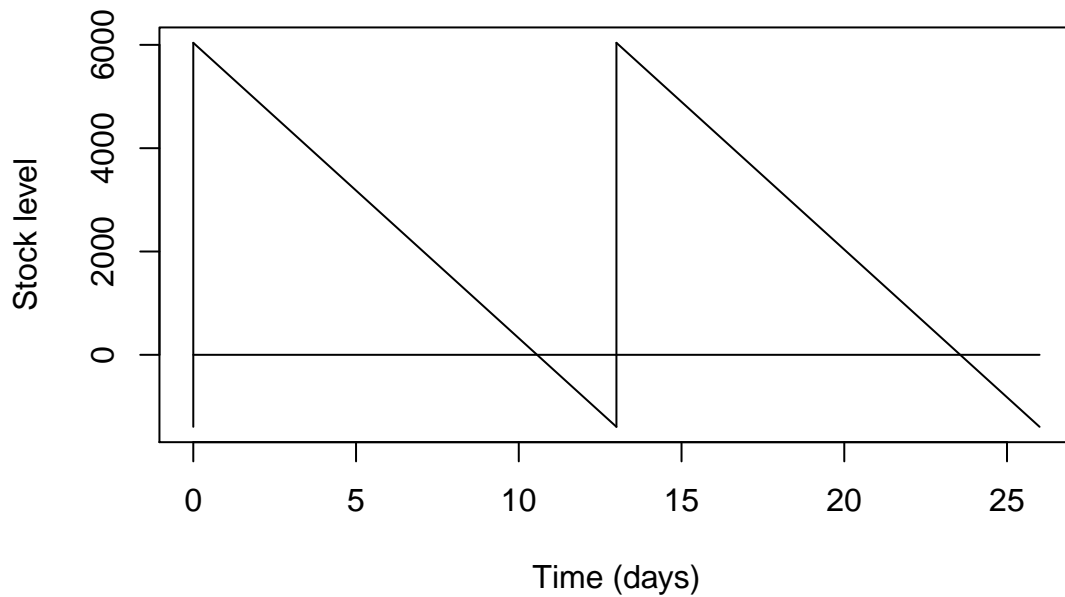
No lead time - orders arrive instantaneously

No back orders

- ii) The Operations Manager is also interested in studying a model in which backorders are permitted. According to its estimates, the cost of backorders is approximately 5% of the total price (price per unit). Determine the best order quantity in the sense that inventory costs are minimised. Write 1 – 2 paragraphs summarising your findings and plot the first two inventory cycles.

Marking criteria • The optimum order quantity, maximum level of stock, optimum time between orders, proportion of time the company have to take backorders, and total annual inventory cost are correctly computed and included in your answer. • The paragraphs clearly explain your findings. • Assumptions of the model are clearly stated. • The first two inventory cycles are correctly plotted

## Inventory cycles for 216233



Optimum ordering quantity 6040

Optimum maximum inventory level 4867

Optimum time between orders 13

Proportion of time taking back orders 23.0769231

Total inventory cost 7300.4389305

Assumptions of model:

known and constant demand

no lead time

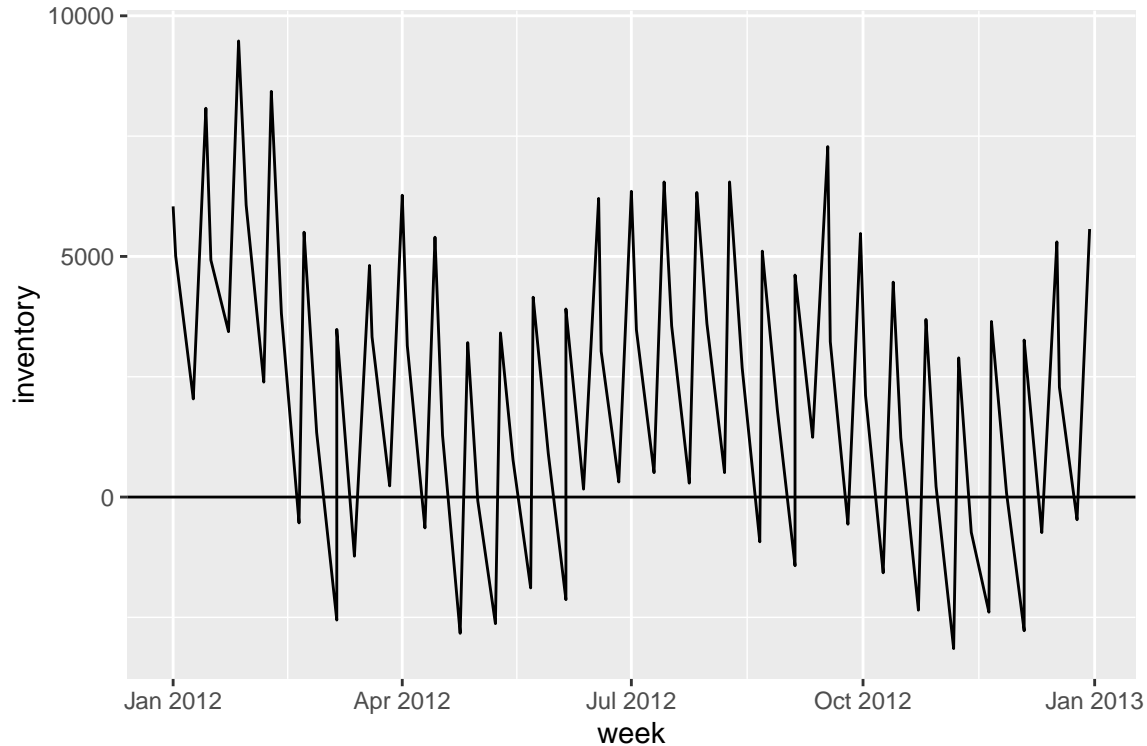
orders arrive instantaneously

back orders allowed

demand can be backordered when no stock

- iii) Plot the inventory cycles associated with the model in part ii and compare with the observed inventory levels in 2012, assuming actual demand during 2012, and the order frequency and order quantity from the model. Write 2 – 3 sentences describing your plot.

Marking criteria • The inventory levels from the model and data are correctly plotted. • Accurate and insightful comments are made about the plot. • Note: This is a bonus question. The maximum mark that could be awarded for this project is 100



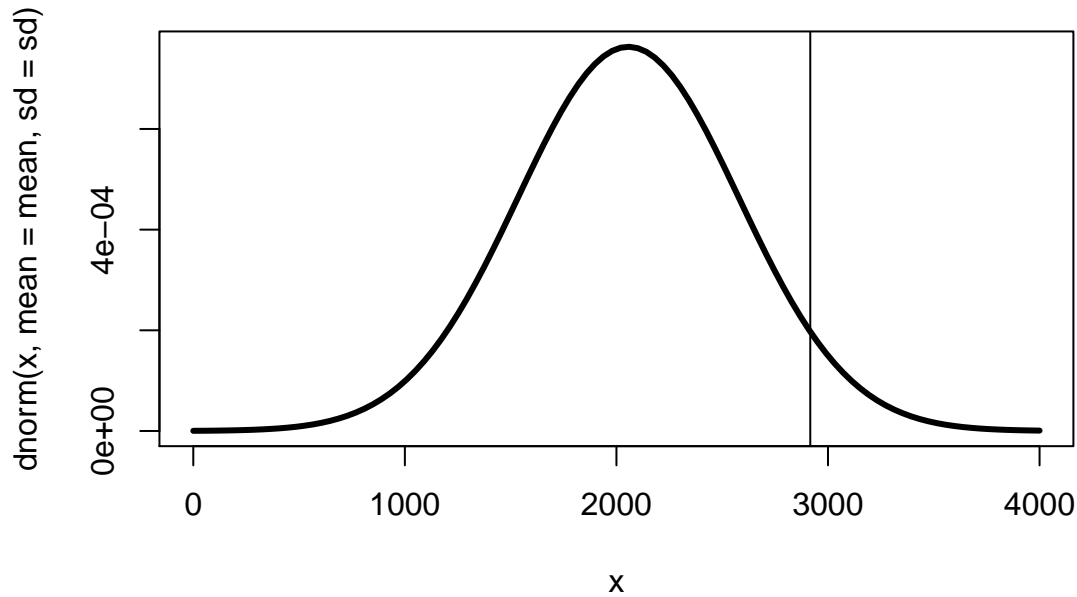
The Operations Manager is considering the option of a multi-period inventory model. The company, as a policy, is not willing to tolerate more than 5% chance of a stock-out. The Operations Manager has estimated that the annual holding cost is 6.50 per unit and the ordering cost is 20.50 per order.

- i. Calculate a multi-period inventory model for product 216425, based on the 2012 sales data. Create plot/s of the weekly average demand of this product. Use the costs stated in part (b) above. Write a paragraph explaining the results of your model and the plot/s.

Hint: Use the weekly demand to estimate the demand during a one-week lead time.

Marking criteria • The optimal order quantity, safety stock, expected annual cost, orders per years are correctly computed and included in your answer. • The paragraph clearly explains your findings. • The assumption of normality for the demand during a one-week lead time is discussed. • The weekly average demand of this product is correctly plotted and discussed





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## integer(0)
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Demand during a one week lead time has been estimated based off 2012 weekly demand. The mean weekly demand from 2012 and standard deviation have been applied to a normal distribution to estimate demand for this multi-inventory model.

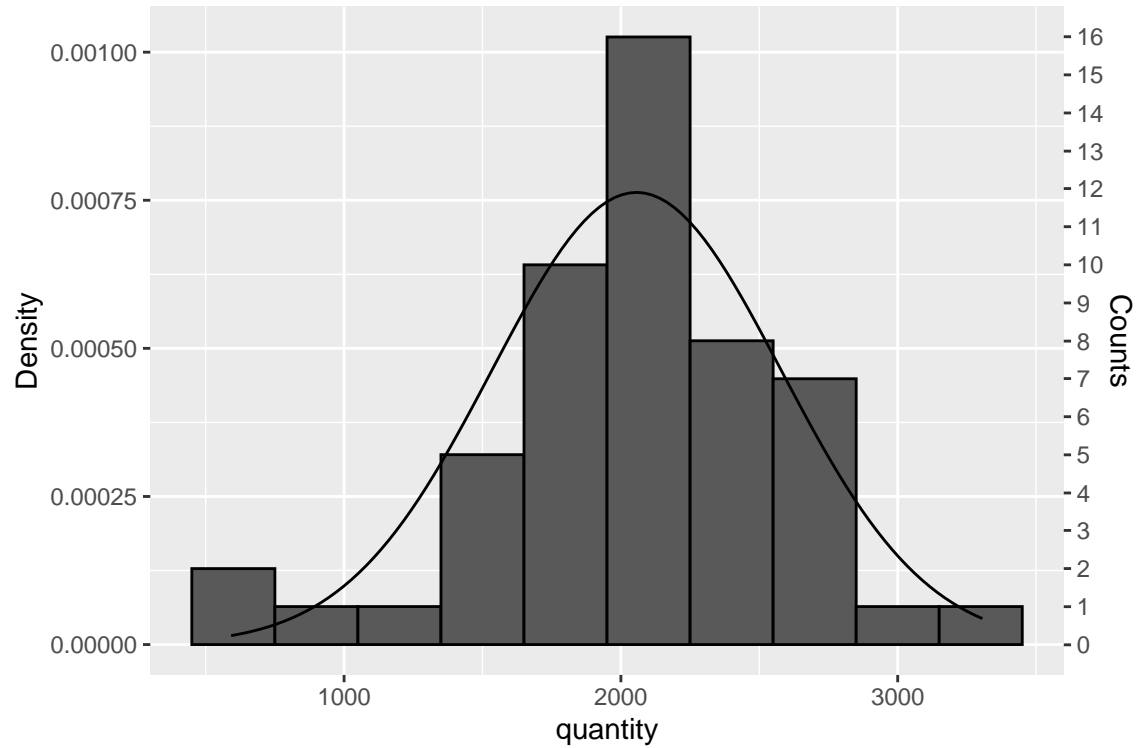
As the plot below shows, the actual demand for 2012 does not perfectly follow a normal distribution. It is difficult to determine the distribution of weekly demand based on only one year of observations. It is recommended that more data is used to for a more accurate model of demand distribution.

Based on 2012, where mean weekly demand was 2056.5192308 with standard deviation of 522.6820535, the expected annual demand is estimated to be  $1.06939 \times 10^5$ .

Given this annual demand and the costs of holding and reordering stock, the recommended multi-inventory model is to order 821 units whenever the order quantity reaches the reorder point of 2916.2547022 units. Approximately 130 orders will be placed per year. Safety stock is 821.

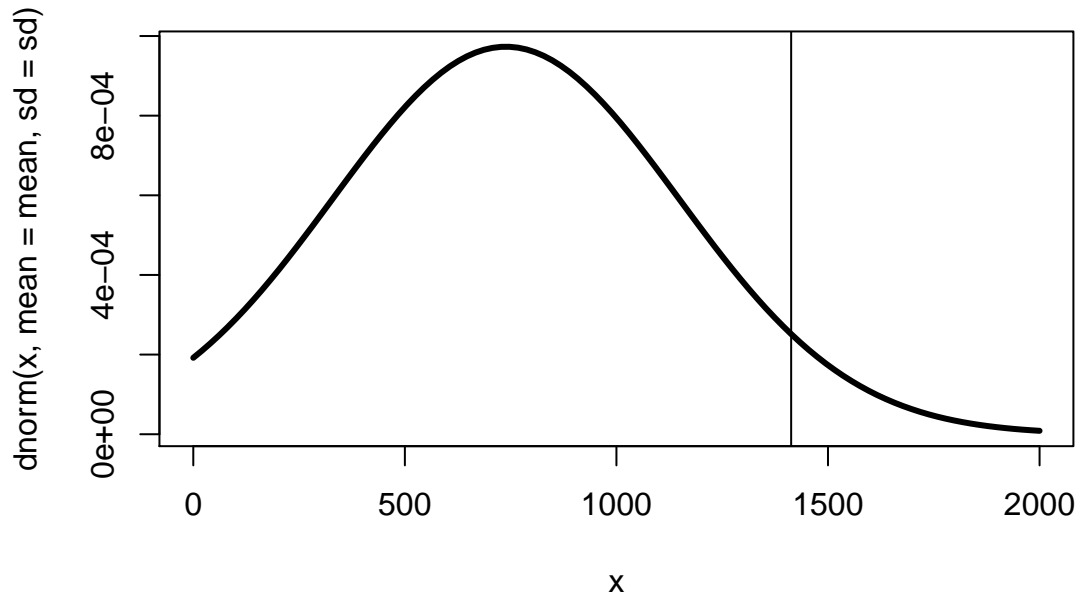
This approach ensures roughly 95% of the time the 2916.2547022 units will be able to satisfy demand during the lead time.

The expected annual costs are  $1.0926749 \times 10^4$  per year. If demand was certain the annual costs would only be  $1.0926749 \times 10^4$ , the additional cost of holding safety stock is the cost of uncertain demand.



2.b.ii. Investigate the use of a multi-period inventory model for the product which has been assigned to your group, based on the 2012 sales data. Create plot/s of the weekly average demand of this product. Use the costs stated in part (b) above.

Discuss the assumptions of the model and suggest a solution, in case of finding any problems. Write a paragraph explaining the results of your findings and the plot.



```
## integer(0)
```

Demand during a one week lead time has been estimated based off 2012 weekly demand. The mean weekly demand from 2012 and standard deviation have been applied to a normal distribution to estimate demand for this multi-inventory model.

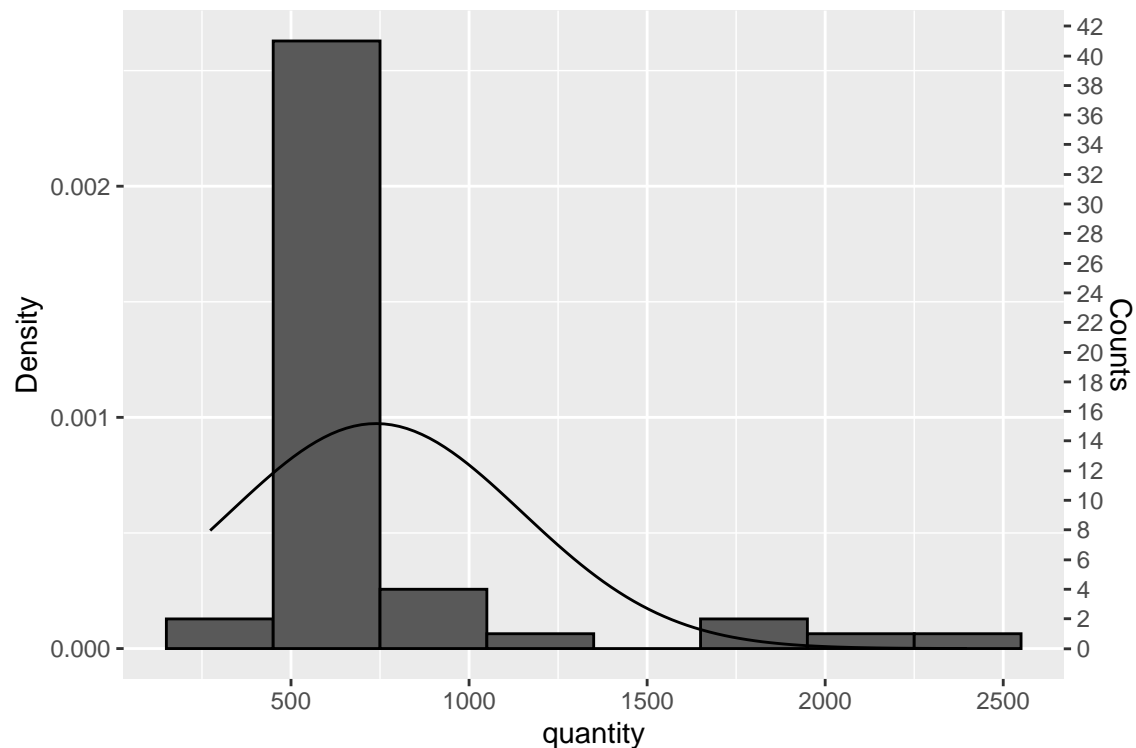
As the plot below shows the observed demand does not follow normal distribution with mean 738.6538462 409.9454715. It is recommended that a more suitable model is used to estimate demand.

Based on the flawed normal model, where mean weekly demand was 738.6538462 with standard deviation of 409.9454715, the expected annual demand is estimated to be  $3.841 \times 10^4$ .

Given this annual demand and the costs of holding and reordering stock, the recommended multi-inventory model is to order 492 units whenever the order quantity reaches the reorder point of 1412.9541418 units. Approximately 78 orders will be placed per year. Safety stock is 492.

This approach ensures roughly 95% of the time the 1412.9541418 units will be able to satisfy demand during the lead time.

The expected annual costs are 7582.3685882 per year. If demand was certain the annual costs would only be 7582.3685882, the additional cost of holding safety stock is the cost of uncertain demand.



## Question 3

### Question 3a

```
## # A tibble: 6 x 14
##   title      brand main_cat price asin  document.id overall verified reviewTime
##   <chr>      <chr> <chr>   <chr> <chr>      <int>    <int> <lgl>    <chr>
## 1 BIC Round ~ BIC Office ~ $2.18 B000~      48735      4 TRUE    05 1, 2018
## 2 BIC Round ~ BIC Office ~ $2.18 B000~      48762      3 TRUE    04 24, 20~
## 3 BIC Round ~ BIC Office ~ $2.18 B000~      48763      5 TRUE    04 22, 20~
## 4 BIC Round ~ BIC Office ~ $2.18 B000~      48774      5 TRUE    04 21, 20~
## 5 BIC Round ~ BIC Office ~ $2.18 B000~      48775      5 TRUE    04 16, 20~
## 6 BIC Round ~ BIC Office ~ $2.18 B000~      48776      4 TRUE    04 10, 20~
## # ... with 5 more variables: reviewerID <chr>, reviewerName <chr>,
## #   reviewText <chr>, summary <chr>, unixReviewTime <int>
```

```
##   Min. 1st Qu. Median    Mean 3rd Qu.    Max.
##  1.000  5.000   5.000  4.669  5.000   5.000
```

