

# HW7

2024-10-27

## 1.

Consider the dataset `txhousing` which is in the `ggplot2` R package. This dataset contains information about 46 Texas cities, recording the number of house sales (`sales`), the total volume of sales (`volume`), the average and median sale prices, the number of houses listed for sale (`listing`) and the number of months inventory (`inventory`). Data is recorded monthly from Jan 2000 to Apr 2015, 187 entries for each city.

### (a)

Plot a time series of sales against date for each city on the same plot using `ggplot2` package. Describe problems that make it hard to see the long-term trend in this plot.

```
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##   filter, lag
```

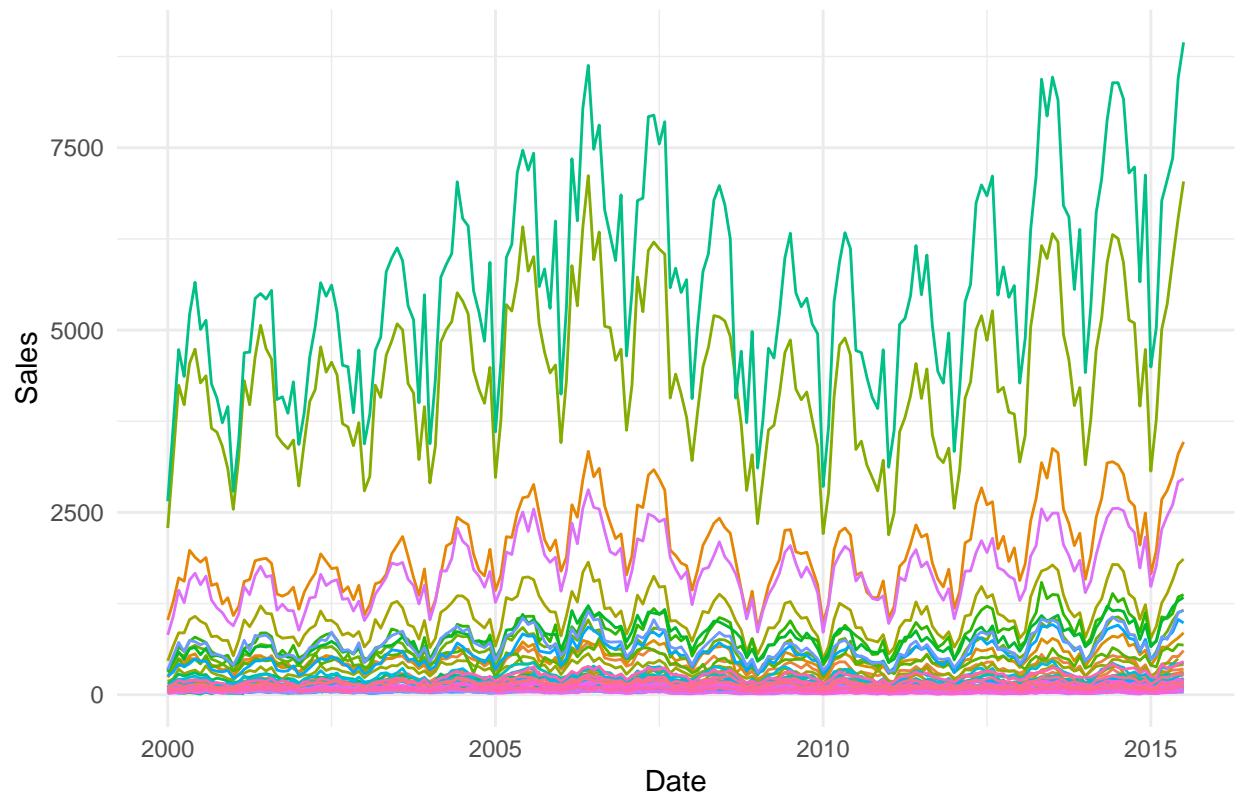
```
## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
```

```
attach(txhousing)

ggplot(txhousing, aes(x = date, y = sales, color = city)) +
  geom_line() +
  labs(title = "Monthly House Sales for Each Texas City",
       x = "Date",
       y = "Sales",
       color = "City") +
  theme_minimal() +
  theme(legend.position = "none")
```

```
## Warning: Removed 430 rows containing missing values or values outside the scale range
## ('geom_line()').
```

## Monthly House Sales for Each Texas City



```
length(unique(txhousing$city))
```

```
## [1] 46
```

```
lowCities <- txhousing |>  
  group_by(city) |>  
  summarize(avgSales = mean(sales, na.rm = TRUE)) |>  
  filter(avgSales < 2500) |>  
  nrow()
```

```
lowCities
```

```
## [1] 44
```

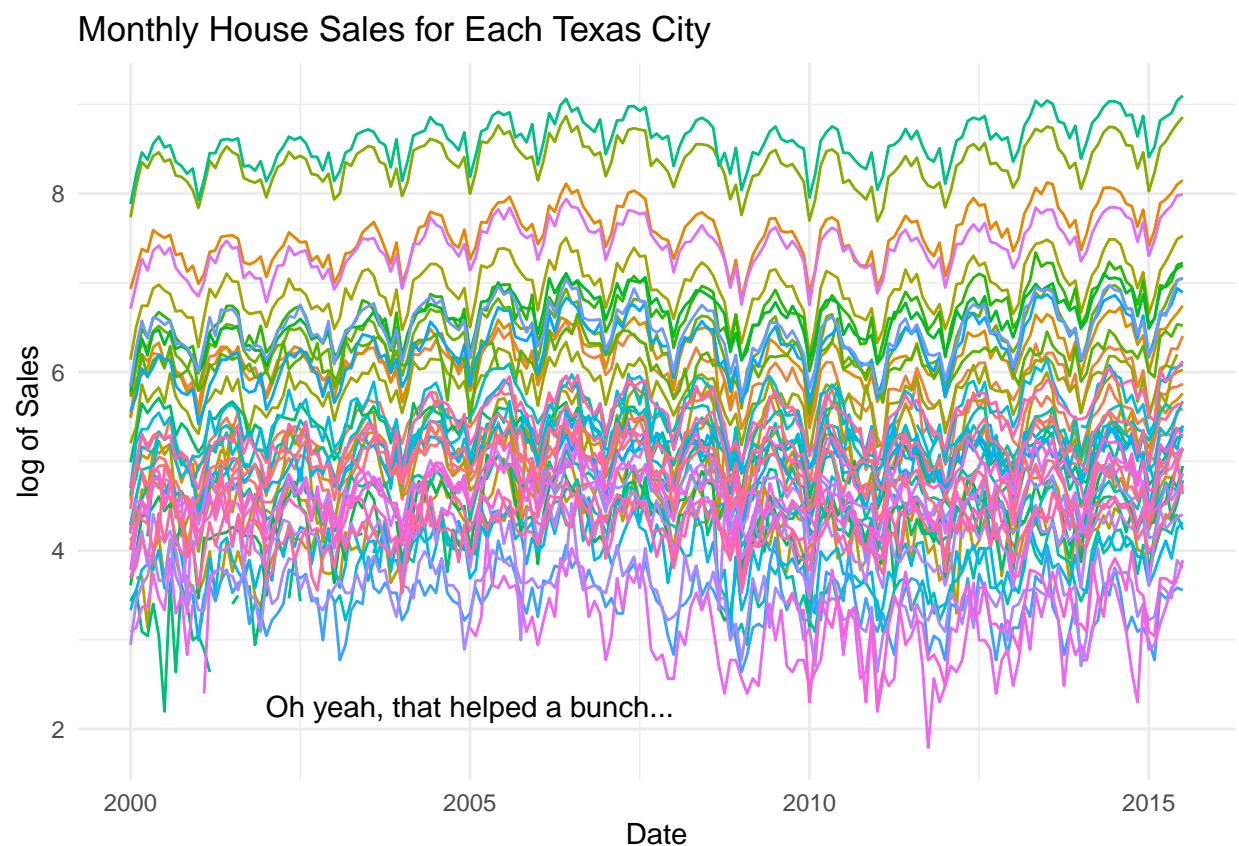
There are a lot of cities in this dataset (46 to be exact)! The fact that so many cluster around 0 to 2500 in “Sales” (44 of 46 average below 2500) means there’s a lot of difficulty distinguishing between trends for most of the cities in the above display.

(b)

We can fix one problem described in (a) by plotting sales in the log-scale. Plot a time series of sales in the log-scale against date for each city on the same plot using `ggplot2`.

```
ggplot(txhousing, aes(x = date, y = log(sales), color = city)) +
  geom_line() +
  labs(title = "Monthly House Sales for Each Texas City",
       x = "Date",
       y = "log of Sales",
       color = "City") +
  theme_minimal() +
  theme(legend.position = "none") +
  annotate("text", x = 2005, y = 2.25, label = "Oh yeah, that helped a bunch...", size = 4, hjust = 0.5)
```

```
## Warning: Removed 430 rows containing missing values or values outside the scale range
## ('geom_line()').
```



(c)

We can fix another problem described in (a) by removing the strong seasonal trend present in the dataset. Fit a linear model with  $\log(\text{sales})$  against month for each city, then create a new column in `txhousing`, call it “`rel_sales`”, which contains the residuals of the linear fits. Then plot a time series of `rel_sales` against date for each city (on the same plot) using `ggplot2`

```
residuals_list <- tapply(X = seq_along(txhousing$sales), INDEX = txhousing$city, FUN = function(idx) {
  lm_fit <- lm(log(txhousing$sales[idx]) ~ txhousing$month[idx], na.action = na.exclude)
  residuals(lm_fit)
```

```

})

txhousing$rel_sales <- unlist(residuals_list)

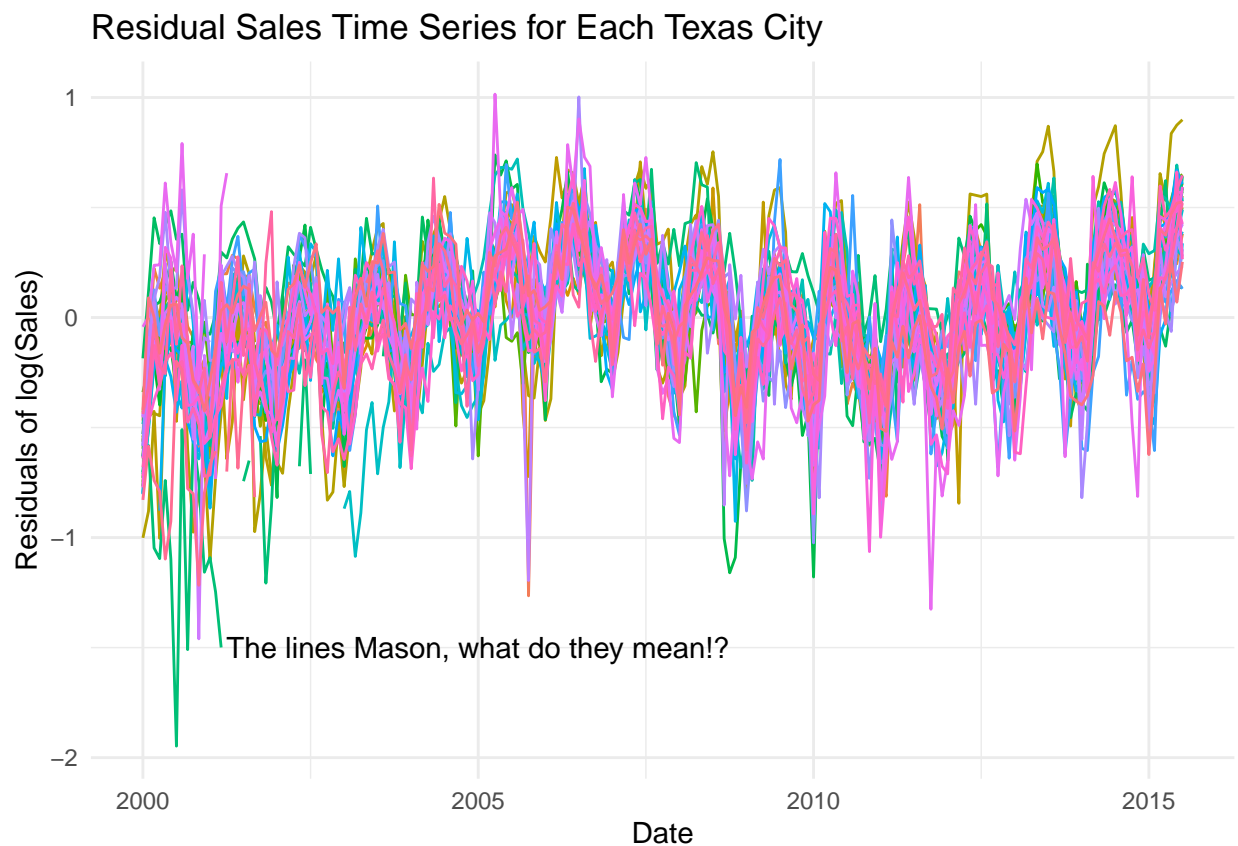
ggplot(txhousing, aes(x = date, y = rel_sales, color = city)) +
  geom_line() +
  labs(title = "Residual Sales Time Series for Each Texas City",
       x = "Date",
       y = "Residuals of log(Sales)",
       color = "City") +
  theme_minimal() +
  theme(legend.position = "none") +
  annotate("text", x = 2005, y = -1.5, label = "The lines Mason, what do they mean!?", size = 4, hjust = 0)

```

```

## Warning: Removed 430 rows containing missing values or values outside the scale range
## ('geom_line()').

```



(d)

On the plot for (c), put in the mean curve using the function `geom_line()` on the R code in (c).

```

# Fighting the urge to use DB language and group_by...
# mean_rel_sales <- txhousing |>

```

```

# group_by(date) />
# summarise(mean_rel_sales = mean(rel_sales, na.rm = TRUE))

mean_rel_sales <- data.frame(
  date = unique(txhousing$date),
  mean_rel_sales = tapply(txhousing$rel_sales, txhousing$date, mean, na.rm = TRUE)
)

# Plot the time series of 'rel_sales' for each city and add the mean curve
ggplot(txhousing, aes(x = date, y = rel_sales, color = city)) +
  geom_line() +
  geom_line(data = mean_rel_sales, aes(x = date, y = mean_rel_sales), color = "black", size = 1.2, line
  labs(title = "Residual Sales Time Series for Each Texas City",
        x = "Date",
        y = "Residuals of log(Sales)",
        color = "City") +
  theme_minimal() +
  theme(legend.position = "none") +
  annotate("text", x = 2005, y = -1.5, label = "Woah", size = 4, hjust = 0.5)

```

```

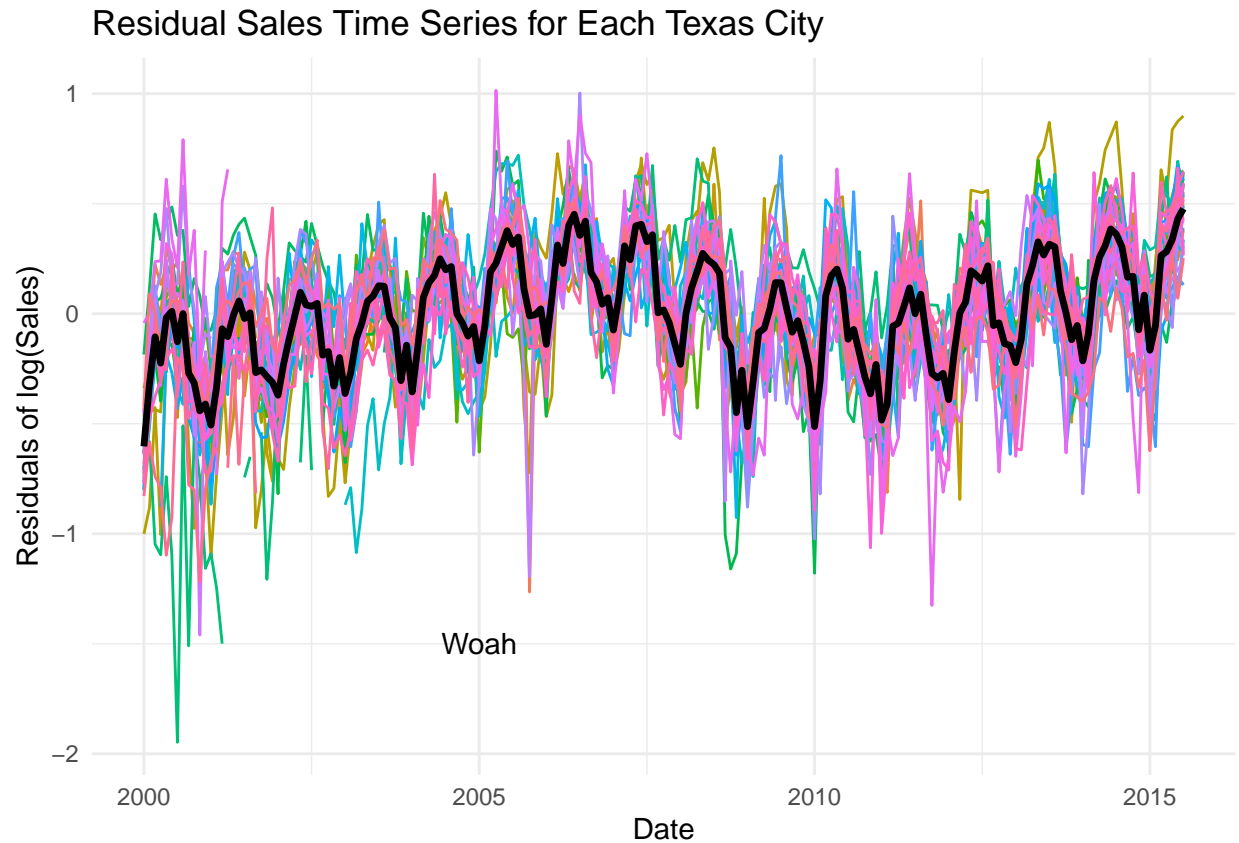
## Warning: Using 'size' aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use 'linewidth' instead.
## This warning is displayed once every 8 hours.
## Call 'lifecycle::last_lifecycle_warnings()' to see where this warning was
## generated.

```

```

## Warning: Removed 430 rows containing missing values or values outside the scale range
## ('geom_line()').

```



(e)

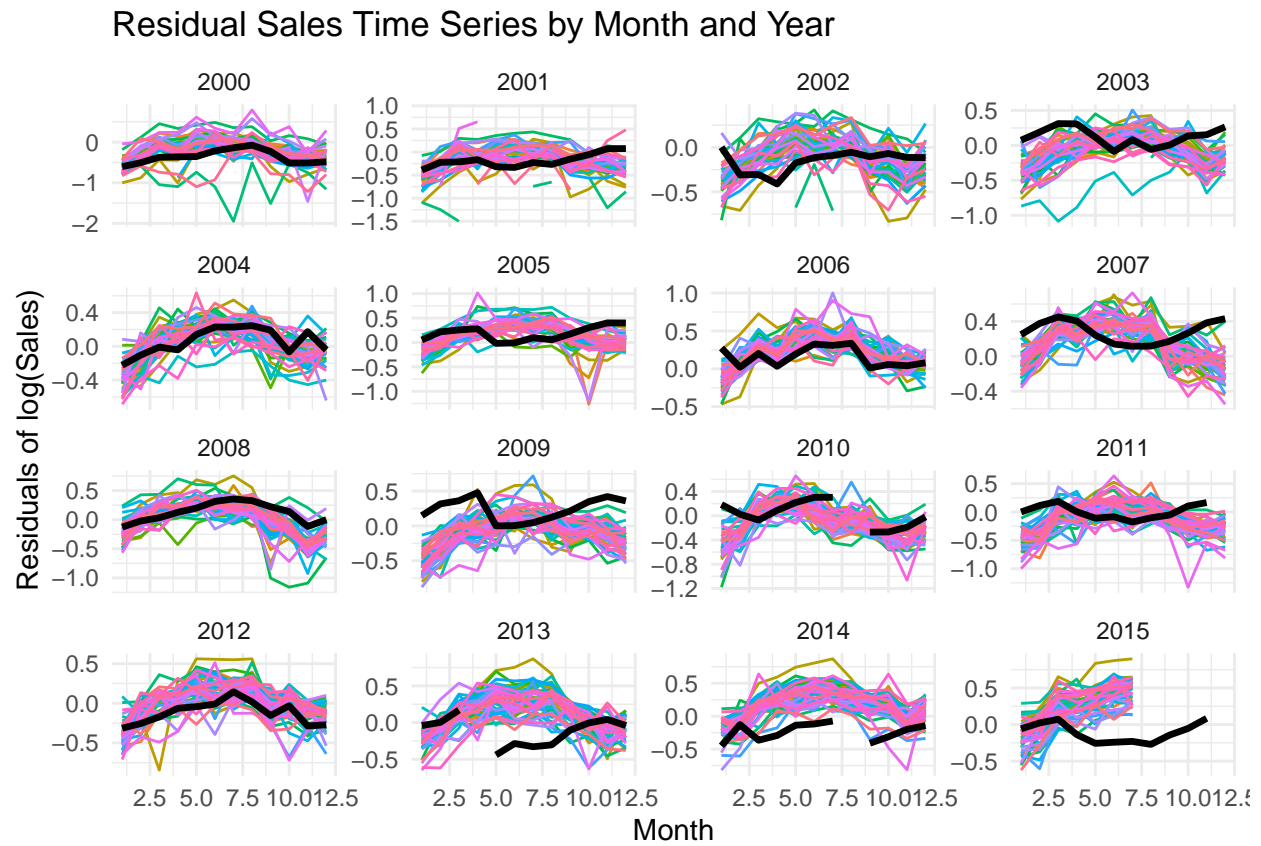
Provide a page of plots of rel sales against month by year using the facet option on ggplot2 package. On each plot, put in the mean curve using geom\_line() options.

```
mean_rel_sales <- data.frame(
  year = rep(unique(txhousing$year), each = 12),
  month = 1:12,
  mean_rel_sales = as.numeric(tapply(X = txhousing$rel_sales,
                                     INDEX = list(txhousing$year, txhousing$month),
                                     FUN = mean,
                                     na.rm = TRUE))
)

ggplot(txhousing, aes(x = month, y = rel_sales, color = city)) +
  geom_line() +
  geom_line(data = mean_rel_sales, aes(x = month, y = mean_rel_sales),
            color = "black", size = 1.2, linetype = "solid") +
  labs(title = "Residual Sales Time Series by Month and Year",
       x = "Month",
       y = "Residuals of log(Sales)",
       color = "City") +
  facet_wrap(~ year, scales = "free_y") +
  theme_minimal() +
  theme(legend.position = "none")
```

```
## Warning: Removed 430 rows containing missing values or values outside the scale range
## ('geom_line()').
```

```
## Warning: Removed 1 row containing missing values or values outside the scale range
## ('geom_line()').
```



## 2.

When a cell phone relay tower is not working properly, wireless providers can lose great deal of money so it is important for them to be aware of and to be able to fix problems expeditiously. A first step toward understanding the problems involved is to collect data from designed experiments involving three factors, as was done in the experiment that gave rise to the dataset available in the file `breakdown.dat`. In this case, a reported problem was initially classified as low or high severity, simple or complex, and the engineer assigned was rated as relatively new (novice) or expert(guru). Two times were observed. The dataset has measurements on severity level of the problem (low/high, column 1), level of complexity of the problem (simple/complex, column 2), experience level of engineer (novice/guru, column 3), and time to assess problem (column 4), implement solution (column 5) and total resolution (column 6).

### (a)

Read the data set and name each column, the variables corresponding names, problem, severity and engineer, i.e., problem for low and high, severity for simple and complex and engineer for new or expert. The names for the last three columns are given by "Assessment","Implementation","Resolution". Note that the resolution is the sum of the time assessment of the problem and the implementation.

### (b)

For the engineer type as a categorical variable on the x axis, create a facet with boxplots for the variables. You may need to use the `reshape2` package. Also rename the y-axis label. What difference can you tell for the engineer for each time?

### (c)

The above boxplot may be hard to interpret for some. For the above, separate the levels severity and create side-by-side boxplots for each level of engineer. What conclusions can you draw from each of these plots?

### (d)

Now create a new faceting plot, by faceting with "Problem" and the three variables. Discuss the plot and draw appropriate conclusions, if any.