615 Midterm Project

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This data cleaning & EDA project was completed by Tianwen (Tina) Huan and Jingrong Cheng. We are curious about how data reflects about climate change, so we found a suitable dataset on Kaggle.com. https://www.kaggle.com/berkeleyearth/climate-change-earth-surface-temperature-data We selected "Global Land Temperatures By City" file to do this project.

```
CT <- read.csv("~/Desktop/GlobalLandTemperaturesByCity.csv")
```

1. Check the original dataset

First of all, we want to know the basic information of this file, so we apply "summary","dim","str" function.

```
summary(CT)
```

```
##           dt          AverageTemperature AverageTemperatureUncertainty
##  1882-01-01:   3510   Min.   :-42.7      Min.   : 0.0
##  1882-02-01:   3510   1st Qu.: 10.3      1st Qu.: 0.3
##  1882-03-01:   3510   Median : 18.8      Median : 0.6
##  1882-04-01:   3510   Mean   : 16.7      Mean   : 1.0
##  1882-05-01:   3510   3rd Qu.: 25.2      3rd Qu.: 1.3
##  1882-06-01:   3510   Max.   : 39.7      Max.   :15.4
##  (Other)   :8578152   NA's   :364130     NA's   :364130
##           City                  Country           Latitude
##  Springfield:   9545   India        :1014906   36.17N : 425455
##  Worcester  :   8359   China        : 827802   34.56N : 351472
##  León       :   7469   United States: 687289   52.24N : 347775
##  Rongcheng  :   6526   Brazil       : 475580   40.99N : 331559
##  Birmingham :   6478   Russia       : 461234   23.31N : 319266
##  Brest      :   6478   Japan        : 358669   50.63N : 308886
##  (Other)    :8554357   (Other)      :4773732   (Other):6514799
##    Longitude
##  139.23E: 129600
##  88.25E :  88842
##  136.22E:  86940
##  0.00W  :  83557
##  46.31W :  82878
##  5.26E  :  64780
##  (Other):8062615
```

```
dim(CT)
```

```
## [1] 8599212       7
```

```
str(CT$Country)
```

```
##  Factor w/ 159 levels "Afghanistan",..: 40 40 40 40 40 40 40 40 40 40 ...
```

Details highlighted: *year/month goes form 1743.11 to 2013.09* 8599211 rows, 159 Countries Due to the dataset is too large, we decided to select a subset data only focusing on United States and from year 1900.

2. Choose the subset

```
cityT <- CT %>%
     filter(Country=="United States") %>% # narrow down to United States
     mutate(date=dt) %>%
     separate(dt, c("year", "month", "day")) %>% # sepearate the year month and day
     filter(year >= 1900)  # select the data after year 1990

# drop the "day" and "Country" columns
cityT <- subset(cityT, select = c(10,1,2,4,5,6,8,9))

# check missing data
cityT[!complete.cases(cityT),]
```

```
##              date year month AverageTemperature
## 10920 2013-09-01 2013    09                 NA
##       AverageTemperatureUncertainty      City Latitude Longitude
## 10920                            NA Anchorage   61.88N   151.13W
```

```
# drop all the data for 2013.09
cityT <- cityT %>%
         filter(year!="2013" | month!="09")

write.csv(cityT, 'cityT.csv')
```

The initial cleaned dataset includes 350805 observations and 9 variables. All the columns: X, date, year, month, Average temperature, average temperature uncertainty, city, latitude, longitude. The order of date is from 1900/1/1 to 2013/8/1.

3. Data character transformation

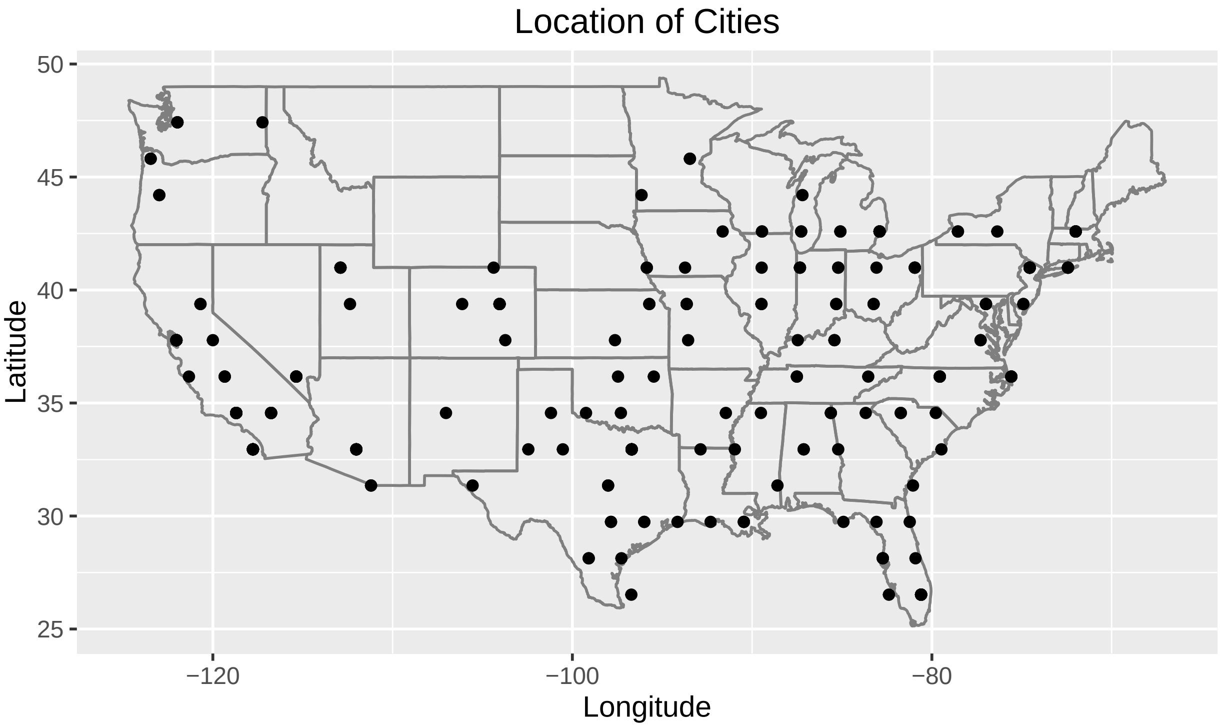
In order to explore data eaiser, we transformed the class of some columns.

```
cityT$date<-as.Date(cityT$date,"%Y-%m-%d")
cityT$year<-as.numeric(cityT$year,"%Y")
cityT$month<-as.numeric(cityT$month,"%m")



cityT$lat<-as.numeric(gsub("N|E|S|W", "",cityT$Latitude))*ifelse(grepl("S",cityT$Latitude),-1,1)
cityT$long<-as.numeric(gsub("N|E|S|W", "", cityT$Longitude))*ifelse(grepl("W",cityT$Longitude),-1,1)

cityT <- data.table(cityT)

# remove Hawaii & Alaska
cityT <- cityT %>%
         filter(long>=-130 & lat>=25 & lat<=55)
```

4. Location Graph According to latitudes and longitude

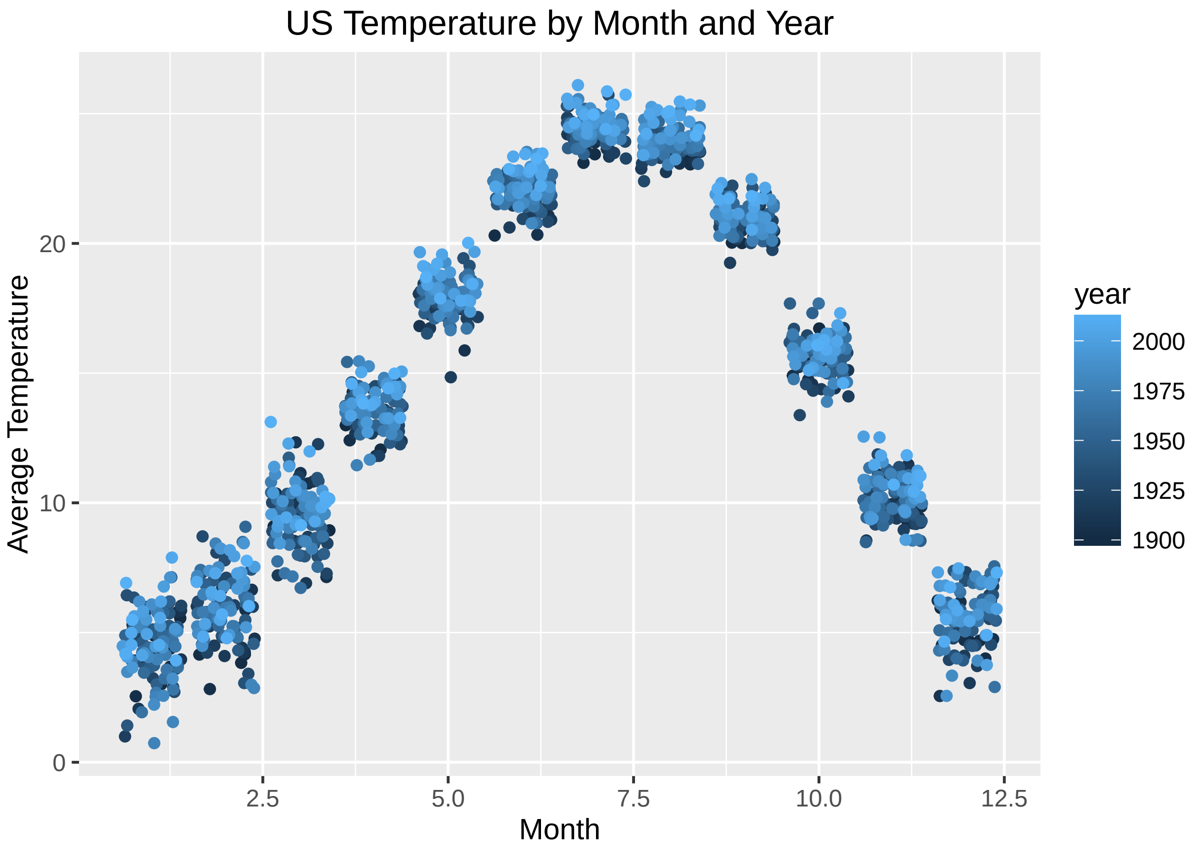
Using groups of latitudes and longitudes to practice "ggplot" function.

```
citylocation <- subset(cityT, select = c("City","lat","long"))
citylocation <- citylocation %>% distinct(.keep_all= FALSE)


ggplot(citylocation, aes(long, lat), col=temp) +
  borders("state") + geom_point()+
  scale_size_area() + coord_quickmap() +
  labs(x="Longitude", y="Latitude", title="Location of Cities")
```

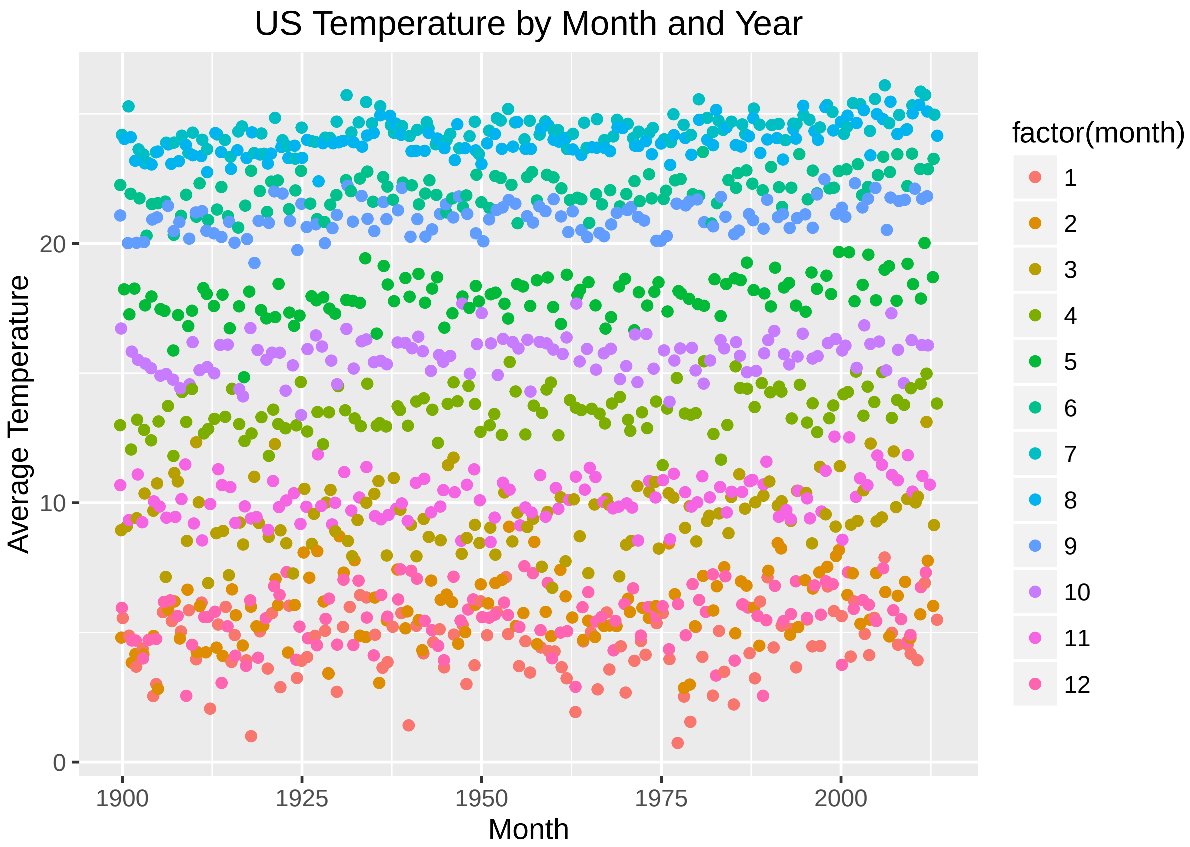


5. US Temperature by Month and Year 1900-2012

```
# choose subset
aT <- cityT %>%
       group_by(year, month) %>%
       summarise(temp=mean(AverageTemperature))

# month trend for different year
ggplot(aT, aes(x=month, y=temp)) +
  geom_jitter(aes(colour=year)) + ggtitle("US Temperature by Month and Year") +
  labs(x="Month", y="Average Temperature")
```

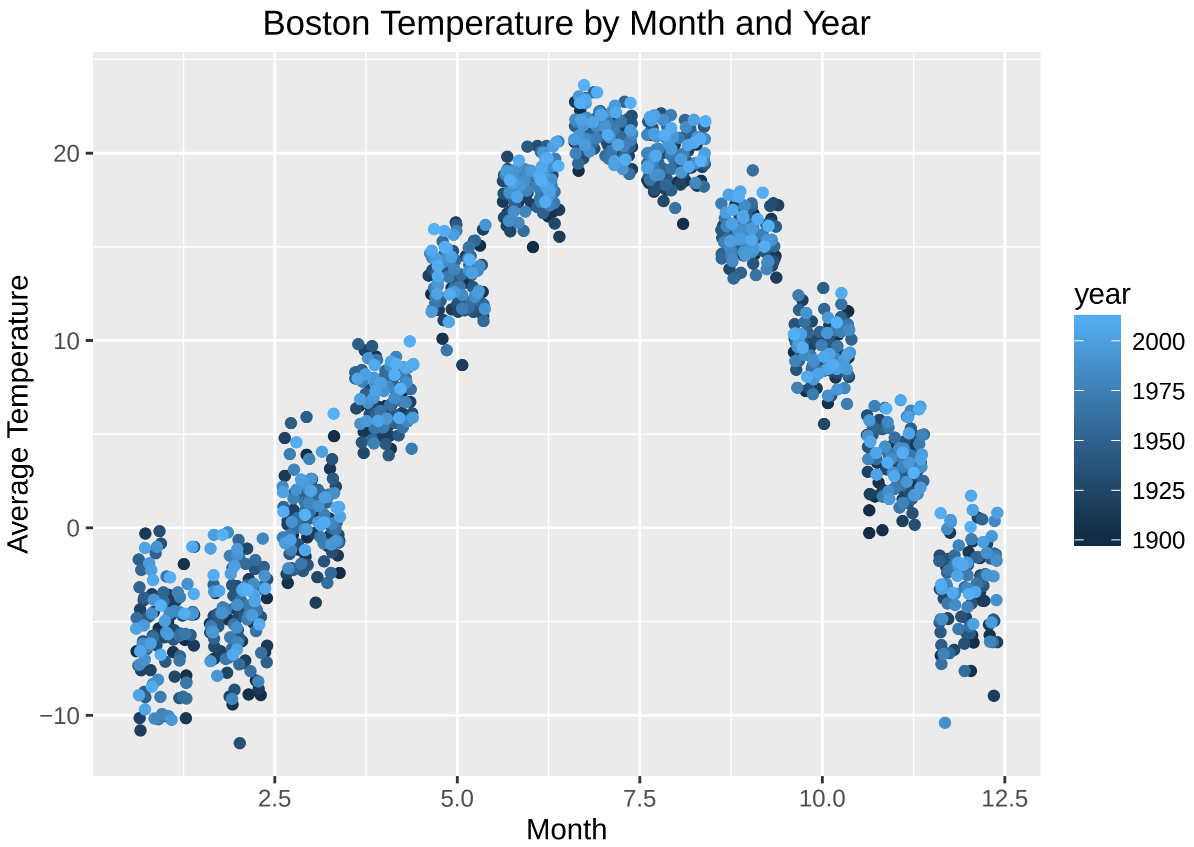


```
# year trend for different month
ggplot(aT, aes(x=year, y=temp)) +
  geom_jitter(aes(colour=factor(month))) +
  ggtitle("US Temperature by Month and Year") +
  labs(x="Month", y="Average Temperature")
```

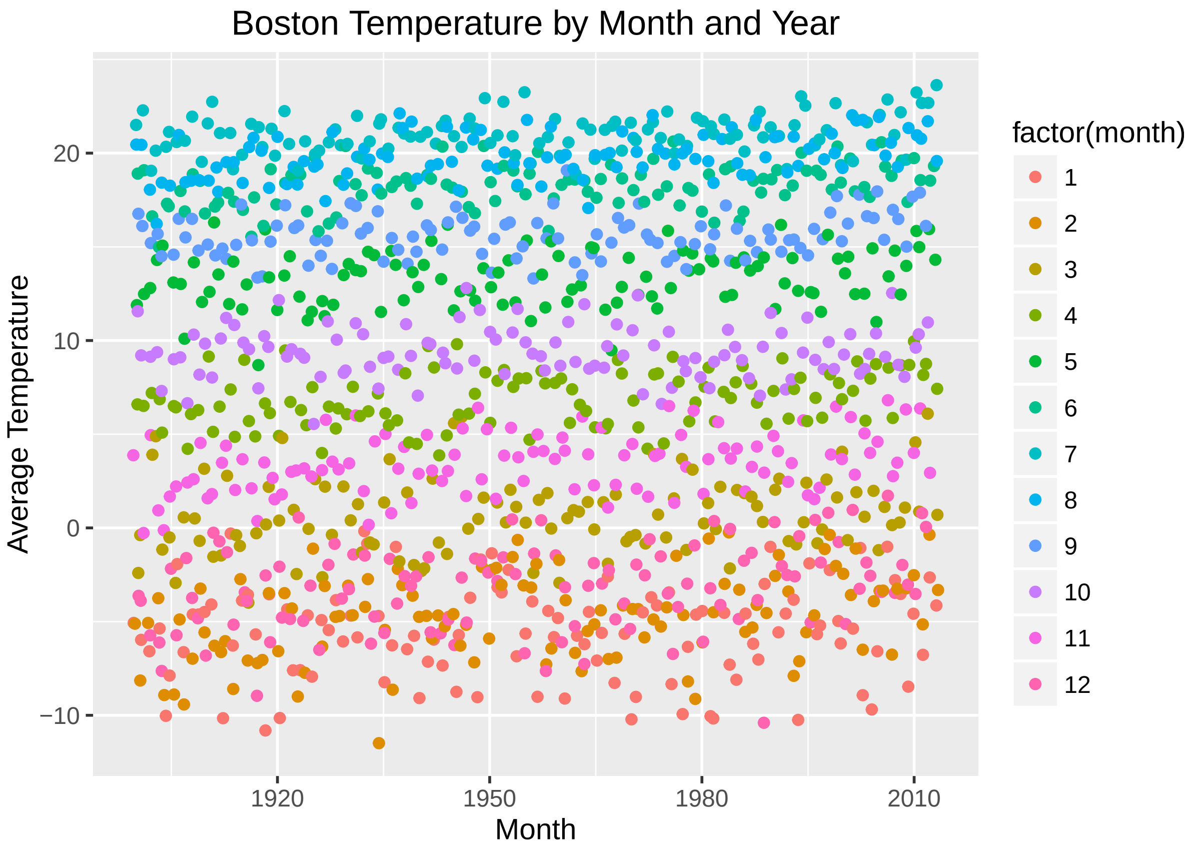


6. Boston Temperature by Month and Year 1900-2012

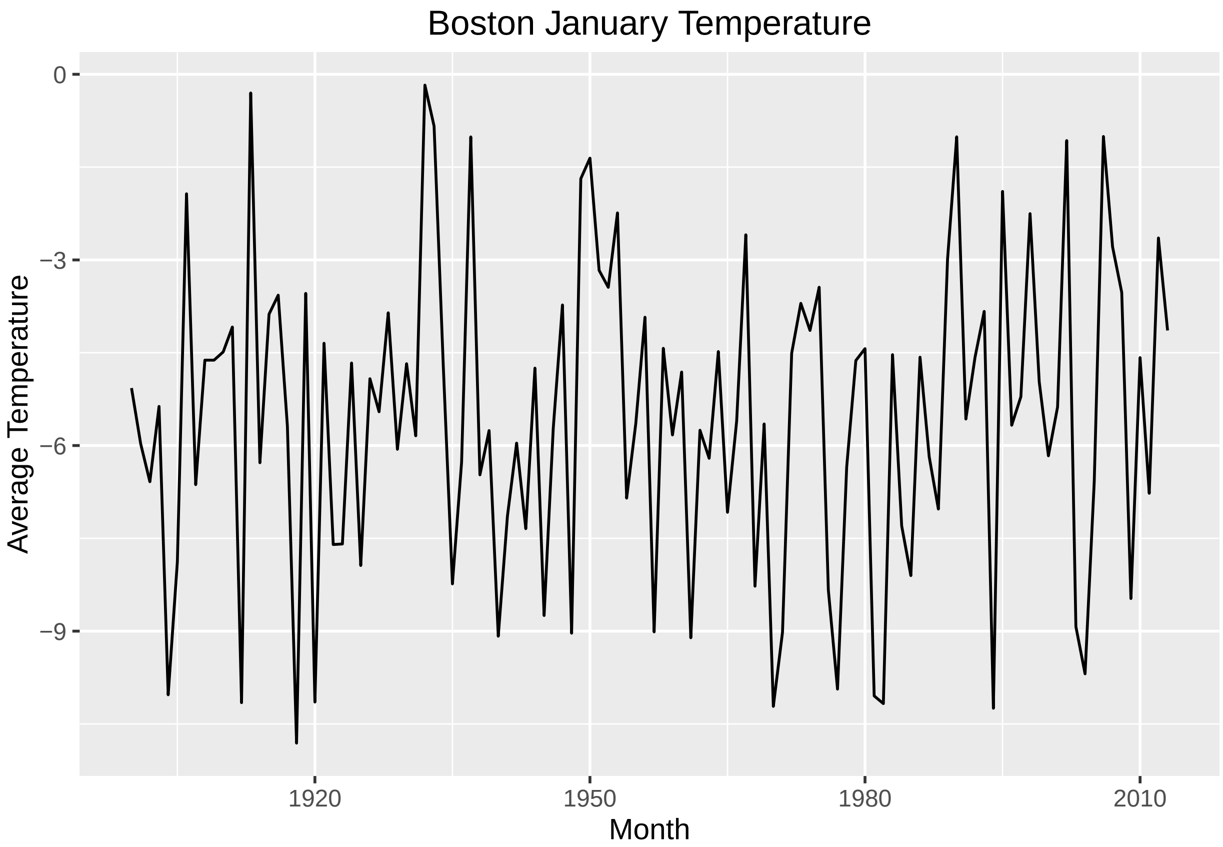
```
# choose subset
aTB <- cityT %>%
       filter(City=="Boston") %>%
       group_by(year, month)

# month trend for different year
ggplot(aTB, aes(x=month, y=AverageTemperature)) +
  geom_jitter(aes(colour=year)) +
  ggtitle("Boston Temperature by Month and Year") +
  labs(x="Month", y="Average Temperature")
```



```
# year trend for different month
ggplot(aTB, aes(x=year, y=AverageTemperature)) +
  geom_jitter(aes(colour=factor(month))) +
  ggtitle("Boston Temperature by Month and Year") +
  labs(x="Month", y="Average Temperature")
```

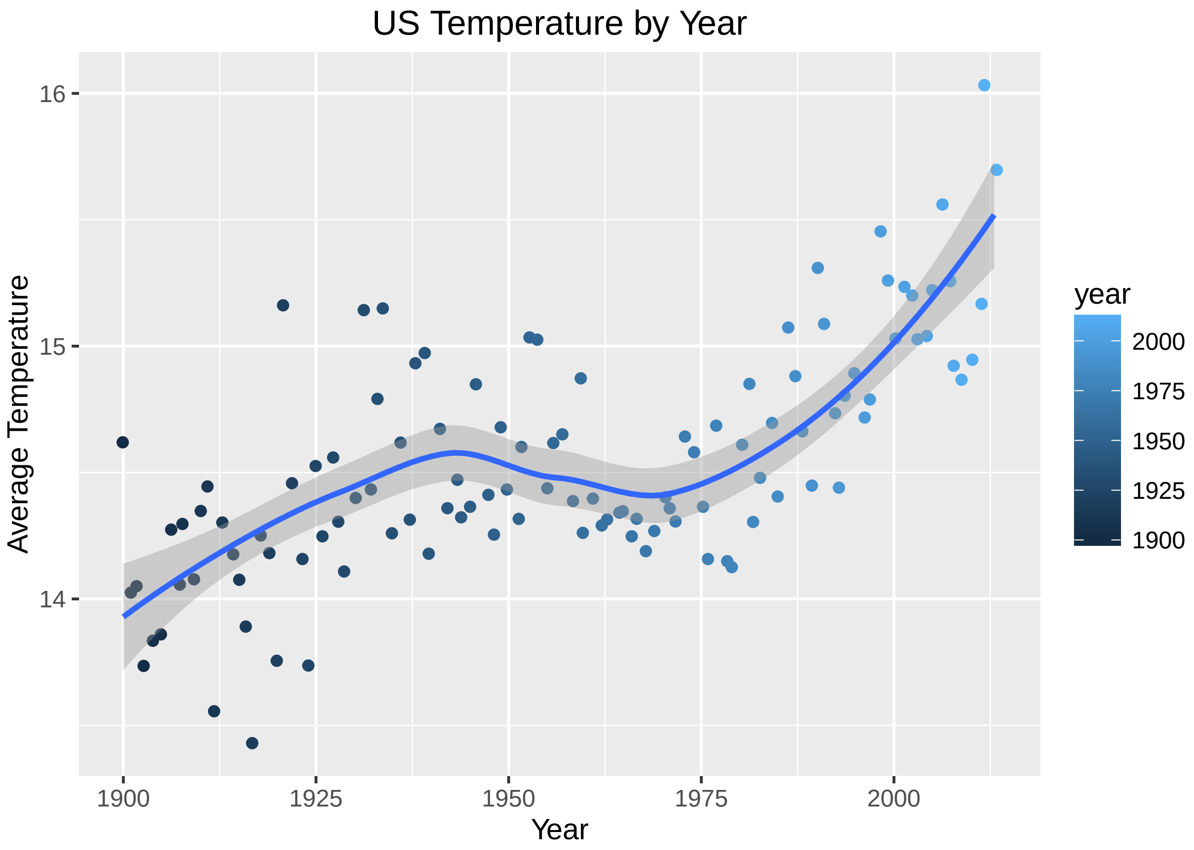


```
# year trend for January
BostonT<- cityT %>% filter(City == "Boston")
bostonjan<-BostonT %>% filter(month == 1)
ggplot(bostonjan, aes(x=year, y=AverageTemperature))+
  geom_line() +
  labs(x="Month", y="Average Temperature", title="Boston January Temperature")
```



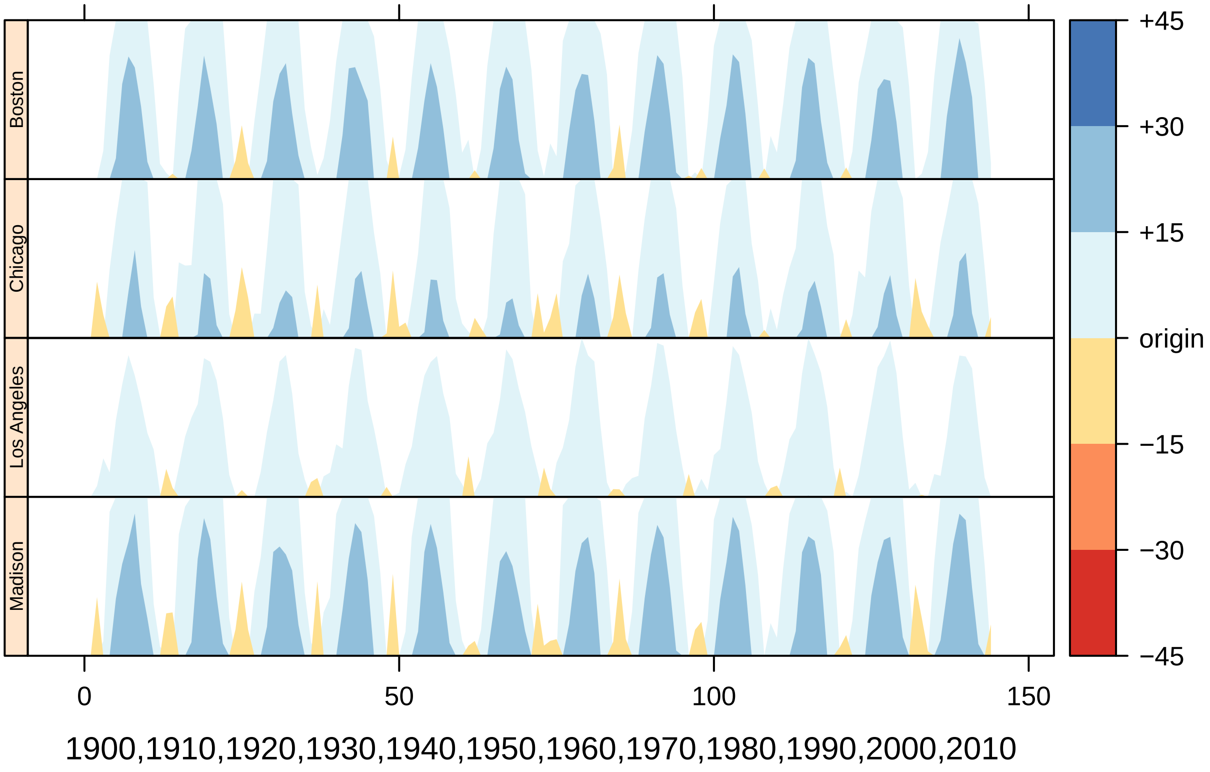
7. US Temperature by Year 1900-2012

```
# choose subset
aTy <- cityT %>%
       group_by(year) %>%
       summarise(temp=mean(AverageTemperature))

# year trend
ggplot(aTy, aes(x=year, y=temp)) +
  geom_jitter(aes(colour=year)) +
  ggtitle("US Temperature by Year") + geom_smooth() +
  labs(x="Year", y="Average Temperature")
```



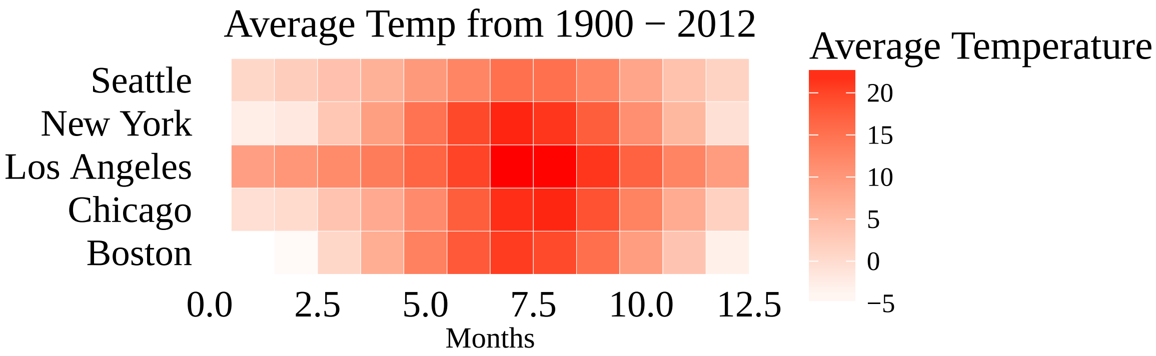
8. Horizonplot

```
y10 <- subset(cityT, year %in% c(1900,1910,1920,1930,1940,1950,1960,1970,1980,1990,2000,2010))

citytable1 <- y10 %>%
             filter(City=="Boston" | City=="Chicago" | City=="Los Angeles" | City=="Madison") %>%
             group_by(year, month, City) %>%
             summarise(temp=AverageTemperature) %>%
             spread(City, temp)

citytable <- subset(citytable1, select=c(3:6))

horizonplot(ts(citytable), horizonscale = 15, colorkey = TRUE,
            xlab="1900,1910,1920,1930,1940,1950,1960,1970,1980,1990,2000,2010")
```



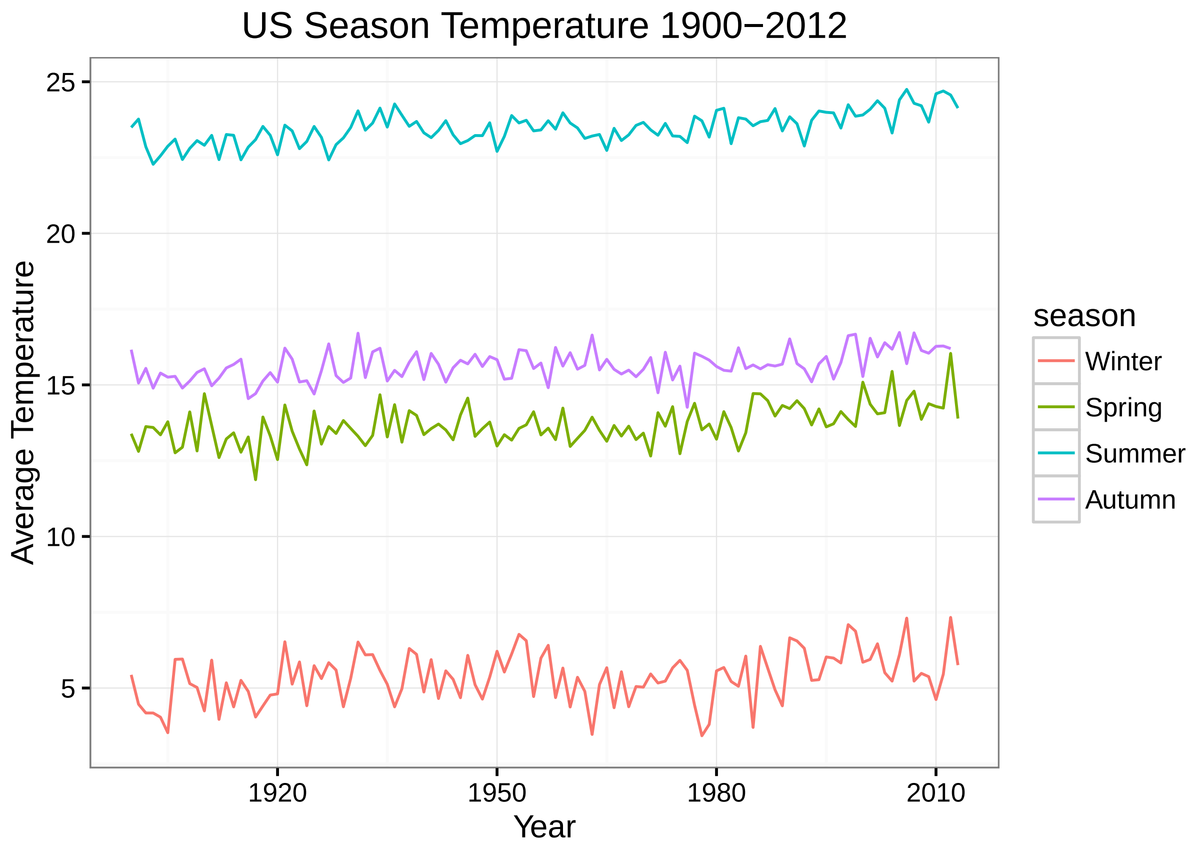
9. Heatmap for 5 main Cities

```
# choose the subset
hm <- cityT %>%
        group_by(month, City) %>%
        summarise(temp=mean(AverageTemperature)) %>%
        filter(City=="Boston" | City=="Chicago" |
                 City=="Los Angeles" | City=="New York" | City=="Seattle")

# Heatmap
ggplot(hm, aes(x=month, y=City, fill=temp, frame=City)) +
  geom_tile(color="white", size=0.1) +
  scale_fill_gradient(name="Average Temperature", low="white", high="red") +
  coord_equal() +
  labs(x = "Months", y = "", title = "Average Temp from 1900 - 2012") +
  theme_tufte() +
  theme(axis.ticks = element_blank()) +
  theme(axis.text = element_text(size = 14)) +
  theme(plot.title = element_text(size = 15)) +
  theme(legend.title = element_text(size = 15)) +
  theme(legend.text = element_text(size = 10))
```

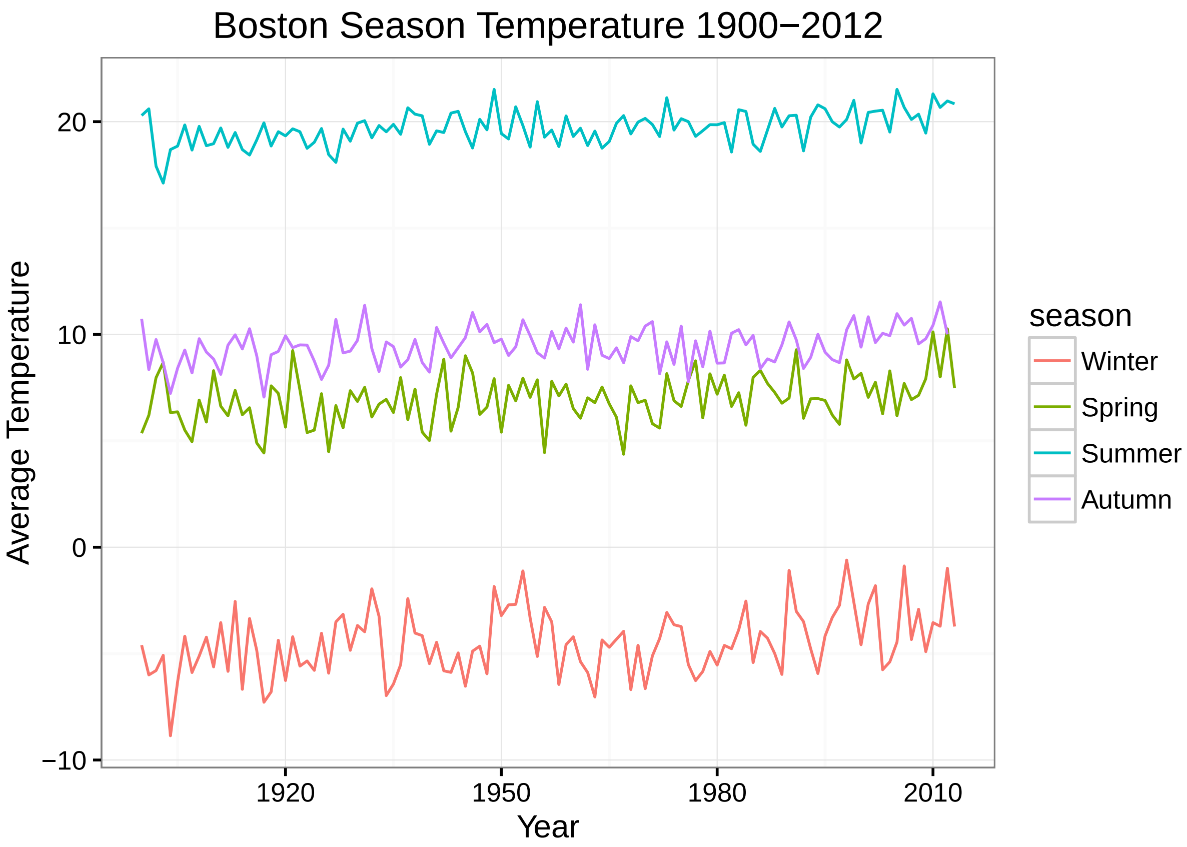


10. Temperature Trend by Season

```
s <- function(m){
            factor((m %% 12) %/% 3, labels = c('Winter', 'Spring', 'Summer', 'Autumn'))}

par(mfrow=c(1,2))
# US Tempreture by Season
sus <- cityT %>%
       group_by(year, season=s(month)) %>%
       summarise(temp=mean(AverageTemperature))

sus %>%
    ggplot(mapping=aes(x=year, y=temp)) +
     geom_line(mapping = aes(color=season)) +
     theme_bw() + labs(x="Year", y="Average Temperature",
                       title="US Season Temperature 1900-2012")
```



```
# Boston Tempreture by Season
sbo <- cityT %>%
       filter(City=="Boston") %>%
       group_by(year, season=s(month)) %>%
       summarise(temp=mean(AverageTemperature))

sbo %>%
    ggplot(mapping=aes(x=year, y=temp)) +
     geom_line(mapping = aes(color=season)) +
     theme_bw() + labs(x="Year", y="Average Temperature",
                       title="Boston Season Temperature 1900-2012")
```


Boston Season Temperature 1900−2012
Average Temperature
20
10
0
−10
1920
1950
1980
2010
Year
season
Winter
Spring
Summer
Autumn