Beige Book Sentiment Analysis

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This is an R Markdown document. Markdown is a simple formatting syntax for authoring web pages and allows both content as well as the output of any embedded R code chunks within a document.

```
## Loading required package: RCurl
## Loading required package: bitops
```

```
## Error: trying to use CRAN without setting a mirror
```

```
## Loading required package: gplots
## KernSmooth 2.23 loaded
## Copyright M. P. Wand 1997-2009
##
## Attaching package: 'gplots'
##
## The following object is masked from 'package:stats':
##
##     lowess
##
## Loading required package: SnowballC
## Loading required package: RColorBrewer
## Loading required package: ggplot2
## Loading required package: twitteR
## Loading required package: ROAuth
## Loading required package: digest
## Loading required package: rjson
## Loading required package: tm
```

```
##
$`https://raw2.github.com/SocialMediaMininginR/sentiment_function/master/sentiment.R`

## function (sentences, pos.words, neg.words, .progress = "none")
## {
##     require(plyr)
##     require(stringr)
##     scores = laply(sentences, function(sentence, pos.words, neg.words) {
##         word.list = str_split(sentence, "\\s+")
##         words = unlist(word.list)
##         pos.matches = match(words, pos.words)
##         neg.matches = match(words, neg.words)
##         pos.matches = !is.na(pos.matches)
##         neg.matches = !is.na(neg.matches)
##         score = sum(pos.matches) - sum(neg.matches)
##         return(score)
##     }, pos.words, neg.words, .progress = .progress)
##     scores.df = data.frame(score = scores, text = sentences)
##     return(scores.df)
## }
```

```
# read.csv() reads a file in table format and creates a data frame from it.
BB <-
read.csv("/Users/heimannrichard/Documents/github/beigebook/beigebookdata/BB_96_2013.csv")

BB <- subset(BB, select = -X)
```

```
# str() compactly display the internal structure of an R object
str(BB)
```

```
## 'data.frame':    1608 obs. of  4 variables:
##  $ location: Factor w/ 12 levels "Atlanta","Boston",..: 10 10 2 2 2 2 2 2 6 9
...
##  $ year    : int  2011 2011 2012 2012 2012 2012 2012 2012 2012 2011 ...
##  $ month   : int  11 10 8 2 1 7 6 4 8 7 ...
##  $ text    : Factor w/ 1608 levels "according to business contacts in the retail
and manufacturing sectors, economic activity in the first district is largely
stag"| __truncated__,..: 252 246 640 651 21 641 639 745 138 1052 ...
```

```
# reformat date field
BB$Date <- as.Date(paste(BB$year, BB$month, BB$day, sep = "-"), format = "%Y-%m-
%d")
BB$Date <- strptime(as.character(BB$Date), "%Y-%m-%d")
# colnames() retrieves column names of a matrix-like object.
colnames(BB) <- c("location", "year", "month", "text", "date")
```

```
# gsub() substitutes character classes that do not give an output such as
# feed, backspace and tabspaces with a space ‘ ‘.  gsub() substitutes
# numerical values with digits of one or greater with a space ‘ ‘.
BB$text <- gsub("[[:punct:]]", " ", BB$text)
BB$text <- gsub("[[:cntrl:]]", " ", BB$text)
BB$text <- gsub("\\d+", " ", BB$text)
```

```
# the standard stopwords are useful starting points but we may want to add
# corpus specific words
stnd.stopwords <- stopwords("SMART")
# head() returns the first parts of a vector, matrix, table, data frame or
# function.  tail() returns the first parts of a vector, matrix, table, data
# frame or function.
head(stnd.stopwords)
```

```
## [1] "a"         "a's"       "able"      "about"     "above"     "according"
```

```
tail(stnd.stopwords)
```

```
## [1] "your"      "yours"     "yourself"  "yourselves" "z"
## [6] "zero"
```

```
# length() gets or set the length of vectors
length(stnd.stopwords)
```

```
## [1] 571
```

```
# bb.stopwords is a combination of stnd.stopwords and our custom list.
bb.stopwords <- c(stnd.stopwords, "district", "districts", "reported", "noted",
    "city", "cited", "activity", "contacts", "chicago", "dallas", "kansas",
    "san", "richmond", "francisco", "cleveland", "atlanta", "sales", "boston",
    "york", "philadelphia", "minneapolis", "louis", "services", "year", "levels",
    " louis")
length(bb.stopwords)
```

```
## [1] 597
```

```
# pos.words is a combination of pos_all, which was quietly loaded and is
# combination of a generic and a domain specific lexicon and # some words
# which are important to the beige book.
pos.words <- c(pos_all, "spend", "buy", "earn", "hike", "increase", "increases",
    "development", "expansion", "raise", "surge", "add", "added", "advanced",
    "advances", "boom", "boosted", "boosting", "waxed", "upbeat", "surge")

# neg.words is a combination of neg_all, which was quietly loaded and is
# combination of a generic and a domain specific lexicon and # some words
# which are important to the beige book.
neg.words <- c(neg_all, "earn", "shortfall", "weak", "fell", "decreases",
"decreases",
    "decreased", "contraction", "cutback", "cuts", "drop", "shrinkage",
"reduction",
    "abated", "cautious", "caution", "damped", "waned", "undermine", "unfavorable",
    "soft", "softening", "soften", "softer", "sluggish", "slowed", "slowdown",
    "slower", "recession")
```

```
head(pos.words)
```

```
## [1] "a+"         "abound"     "abounds"    "abundance"  "abundant"
## [6] "accessable"
```

```
head(neg.words)
```

```
## [1] "2-faced"    "2-faces"    "abnormal"   "abolish"    "abominable"
## [6] "abominably"
```

```
# BB.keeps are the fields we wish to retain after running score.sentiment.
BB.keeps <- BB[, c("location", "date", "year")]
```

```
# using our score.sentiment function on BB$text (text field) against
# pos.words and neg.words (lexicons).
BB.score <- score.sentiment(BB$text, pos.words, neg.words)
```

```
# add back BB.keeps to BB.score.
BB.sentiment <- cbind(BB.keeps, BB.score)
```

```
# colnames shows that we kept “text”, “date”, and “year” field as well as
# the # new column “score”
colnames(BB.sentiment)
```

```
## [1] "location" "date"     "year"     "score"    "text"
```

```
# calculate mean from raw score
BB.sentiment$mean <- mean(BB.sentiment$score)
# calculate sum and store it in BB.sum
BB.sum <- BB.sentiment$score
# center the data by subtracting BB.sum from BB.sentiment$mean
BB.sentiment$centered <- BB.sum - BB.sentiment$mean
# we can label observations above and below the centered values with 1 and
# code N/A values with 0.
BB.sentiment$pos[BB.sentiment$centered > 0] <- 1
BB.sentiment$neg[BB.sentiment$centered < 0] <- 1
BB.sentiment$neg[is.na(BB.sentiment$neg)] <- 0
BB.sentiment$pos[is.na(BB.sentiment$pos)] <- 0
```

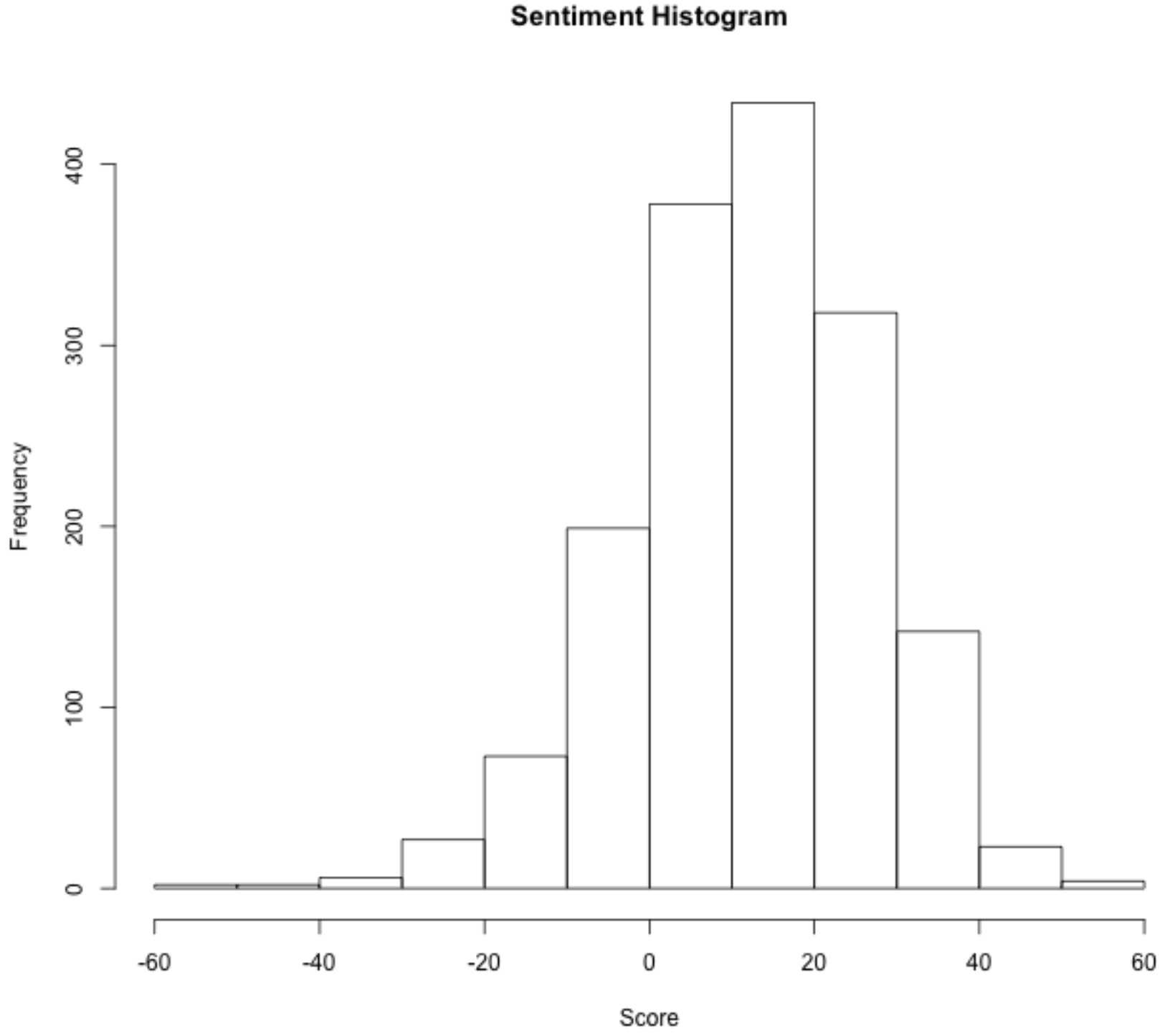
```
# we can then sum the values
sum(BB.sentiment$pos)
```

```
## [1] 853
```

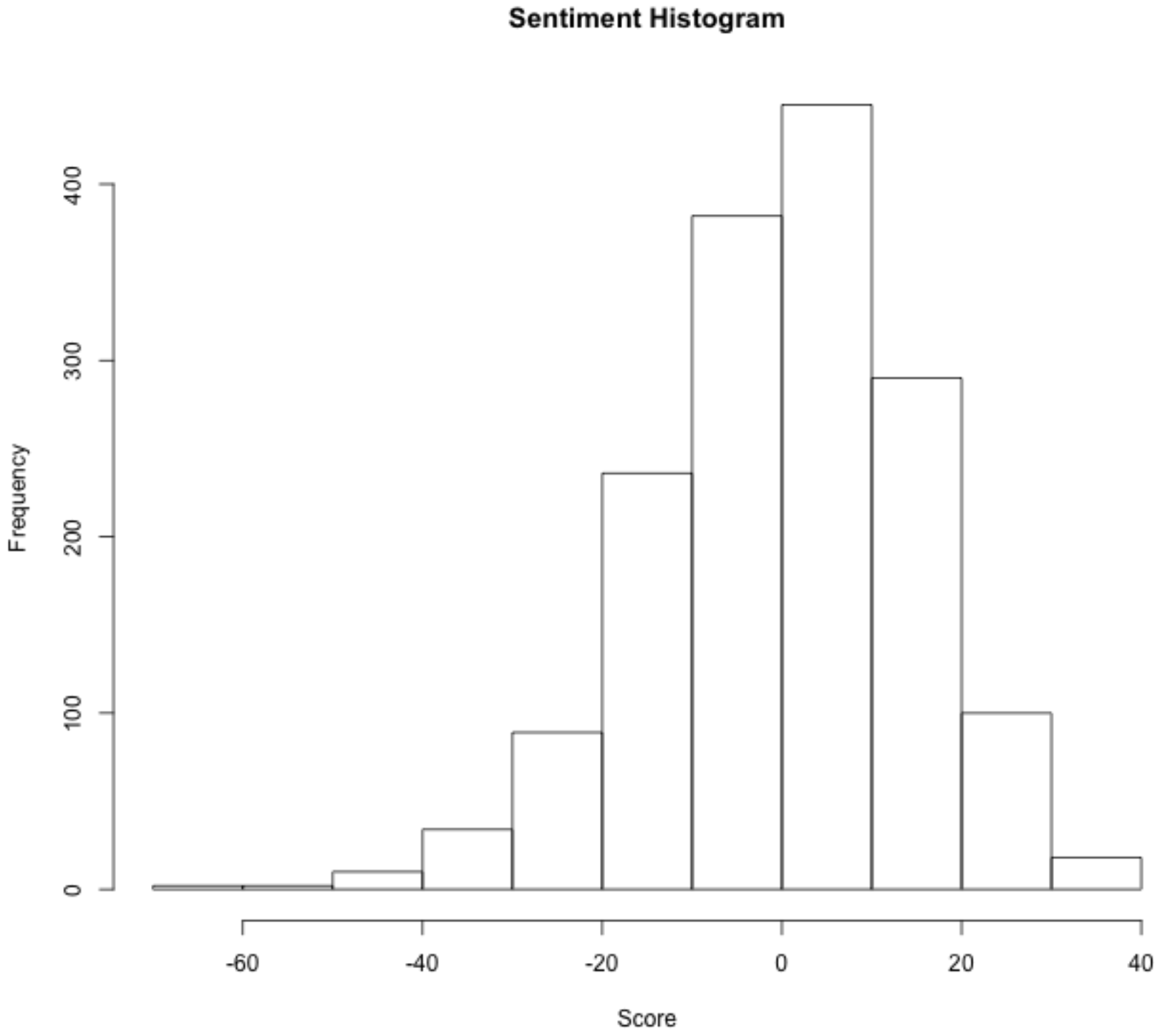
```
sum(BB.sentiment$neg)
```

```
## [1] 755
```

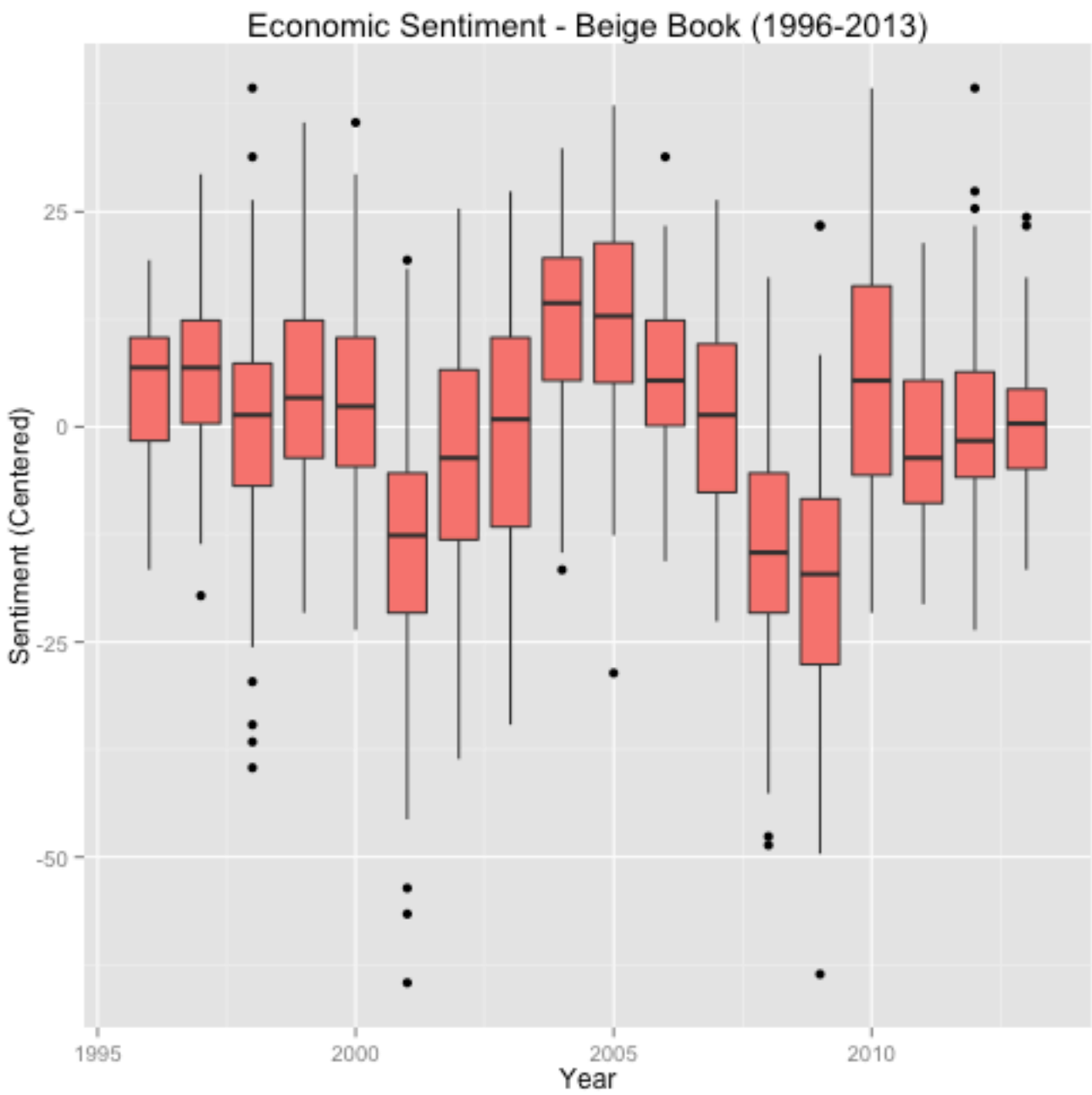
```
# we can create a histogram of raw score and centered score to see the
# impact of mean centering
BB.hist <- hist(BB.sentiment$score, main = "Sentiment Histogram", xlab = "Score",
    ylab = "Frequency")
```




```
BB.hist <- hist(BB.sentiment$centered, main = "Sentiment Histogram", xlab =
"Score",
    ylab = "Frequency")
```

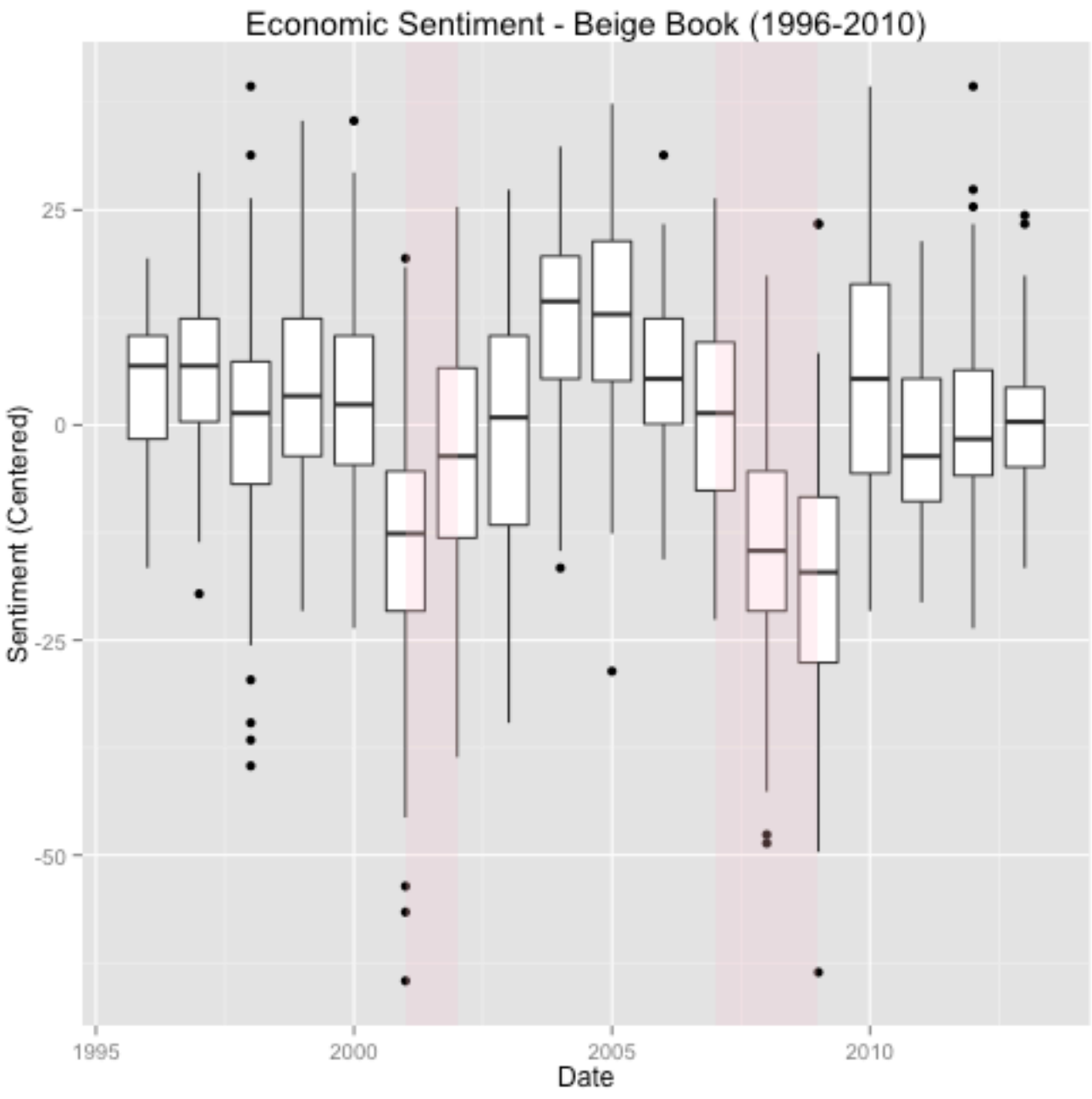



```
# using the results from the function to score our documents we create a
# boxplot to examine the distribution of opinion relating to economic
# conditions
BB.boxplot <- ggplot(BB.sentiment, aes(x = BB.sentiment$year, y =
BB.sentiment$centered,
    group = BB.sentiment$year)) + geom_boxplot(aes(fill = "grey80"), outlier.colour
= "black",
    outlier.shape = 16, outlier.size = 2) + guides(fill = FALSE)
# add labels to our boxplot using xlab
BB.boxplot <- BB.boxplot + xlab("Year") + ylab("Sentiment (Centered)") +
ggtitle("Economic Sentiment - Beige Book (1996-2013)")
# draw boxplot
BB.boxplot
```




```
# this code can be used to add the recession bars shown below where xmin and
# xmax.
rect2001 <- data.frame(xmin = 2001, xmax = 2002, ymin = -Inf, ymax = Inf)
rect2007 <- data.frame(xmin = 2007, xmax = 2009, ymin = -Inf, ymax = Inf)
```

```
# ggplot is an R package used for advanced plotting.
BB.boxplot <- ggplot(BB.sentiment, aes(x = BB.sentiment$year, y =
BB.sentiment$centered,
    group = BB.sentiment$year))
BB.boxplot <- BB.boxplot + geom_boxplot(outlier.colour = "black", outlier.shape =
16,
    outlier.size = 2)
BB.boxplot <- BB.boxplot + geom_rect(data = rect2001, aes(xmin = xmin, xmax = xmax,
    ymin = -Inf, ymax = +Inf), fill = "pink", alpha = 0.2, inherit.aes = FALSE)
BB.boxplot <- BB.boxplot + geom_rect(data = rect2007, aes(xmin = xmin, xmax = xmax,
    ymin = -Inf, ymax = +Inf), fill = "pink", alpha = 0.2, inherit.aes = FALSE)
BB.boxplot <- BB.boxplot + xlab("Date") + ylab("Sentiment (Centered)") +
ggtitle("Economic Sentiment - Beige Book (1996-2010)")
BB.boxplot
```




```
bb.results <- data.frame()
for (local in unique(BB.sentiment$location)) {
    tmp = subset(BB.sentiment, location == local)
    count = nrow(tmp)
    mean = mean(tmp$centered)
    median = median(tmp$centered)
    bb.results = rbind(bb.results, data.frame(local, count, mean, median))
}
bb.results
```

```
##             local count     mean  median
## 1        Richmond   134  0.91231  2.3825
## 2          Boston   134  2.07649  3.8825
## 3     Kansas City   134  2.40485  2.8825
## 4    Philadelphia   134  5.52425  5.8825
## 5   San Francisco   134  0.69590  2.8825
## 6         Atlanta   134 -2.36381 -1.6175
## 7       Cleveland   134  4.03172  3.3825
## 8       St. Louis   134 -8.17724 -7.6175
## 9        New York   134 -1.11754 -1.1175
## 10    Minneapolis   134 -0.05784  0.3825
## 11        Chicago   134  1.53172  3.3825
## 12         Dallas   134 -5.46082 -3.1175
```

```
summary(BB.sentiment$score)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   -52.0     4.0    14.0    12.6    23.0    52.0
```

```
summary(BB.sentiment$centered)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##  -64.60   -8.62    1.38    0.00   10.40   39.40
```

```
# apply a function to each cell in this case using ?mean, ?var, ?length
tapply(BB.sentiment$score, BB.sentiment$location, mean)
```

```
##       Atlanta        Boston       Chicago     Cleveland        Dallas
##        10.254        14.694        14.149        16.649         7.157
##   Kansas City   Minneapolis      New York  Philadelphia      Richmond
##        15.022        12.560        11.500        18.142        13.530
## San Francisco     St. Louis
##        13.313         4.440
```

```
tapply(BB.sentiment$centered, BB.sentiment$location, mean)
```

```
##       Atlanta        Boston       Chicago     Cleveland        Dallas
##      -2.36381       2.07649       1.53172       4.03172      -5.46082
##   Kansas City   Minneapolis      New York  Philadelphia      Richmond
##       2.40485      -0.05784      -1.11754       5.52425       0.91231
## San Francisco     St. Louis
##       0.69590      -8.17724
```

```
tapply(BB.sentiment$score, BB.sentiment$location, var)
```

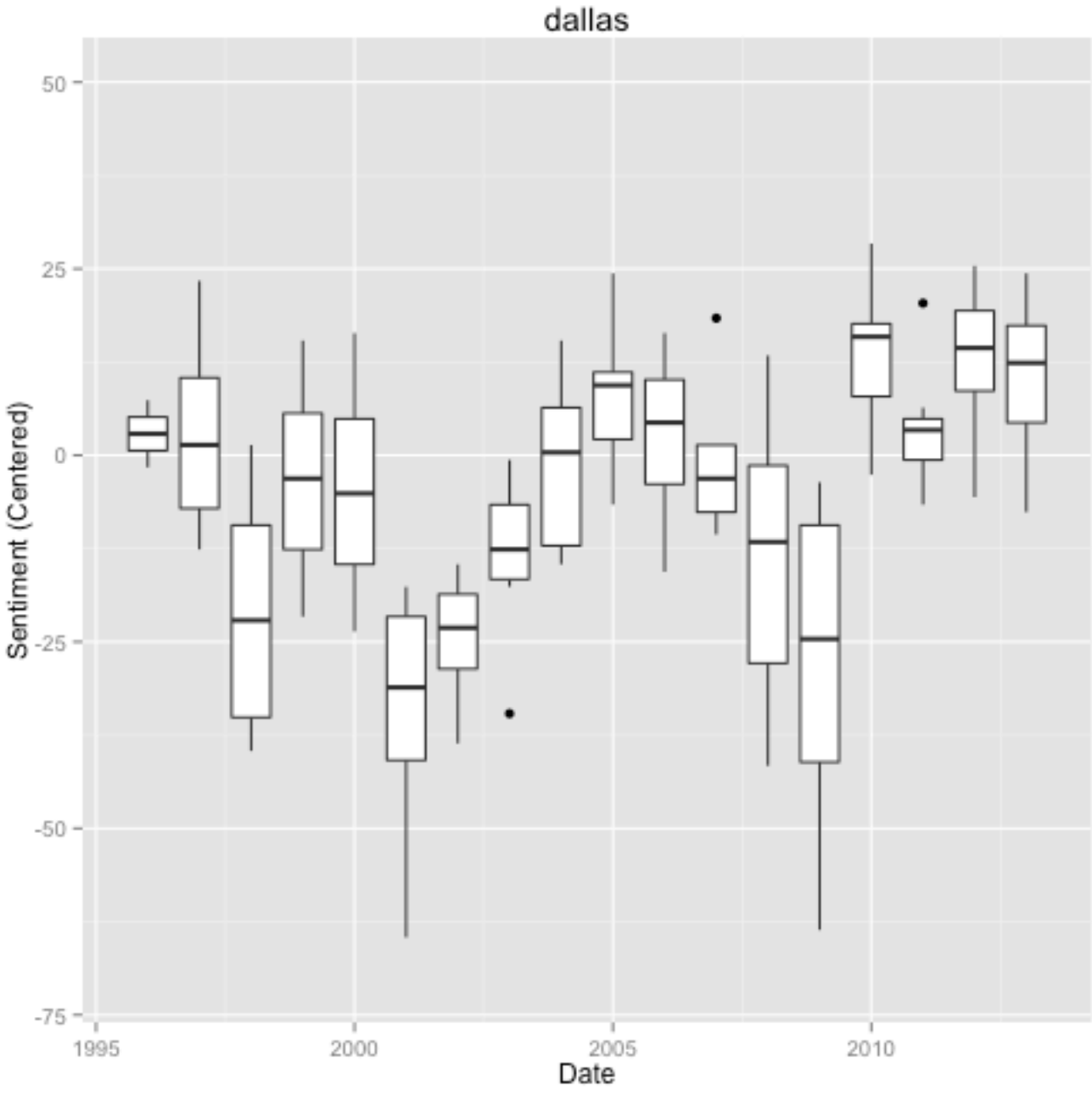
```
##       Atlanta        Boston       Chicago     Cleveland        Dallas
##         171.6         239.1         250.8         146.1         352.2
##   Kansas City   Minneapolis      New York  Philadelphia      Richmond
##         193.2         137.3         168.0         184.2         225.5
## San Francisco     St. Louis
##         263.1         100.6
```

```
tapply(BB.sentiment$score, BB.sentiment$location, length)
```

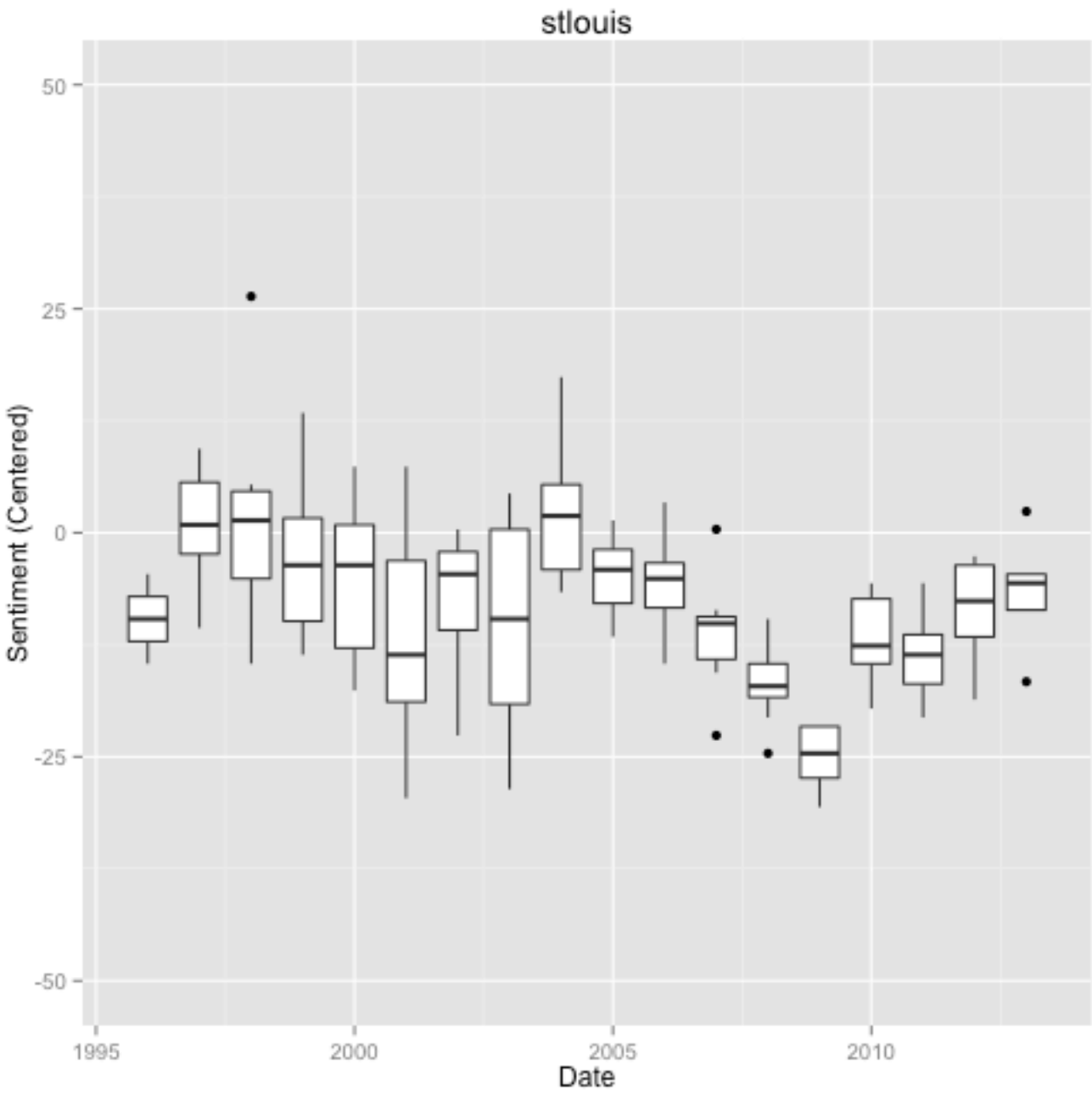
```
##       Atlanta        Boston       Chicago     Cleveland        Dallas
##           134           134           134           134           134
##   Kansas City   Minneapolis      New York  Philadelphia      Richmond
##           134           134           134           134           134
## San Francisco     St. Louis
##           134           134
```

```
# Return subsets of vectors, matrices or data frames which meet conditions.
dallas <- subset(BB.sentiment, location == "Dallas")
stlouis <- subset(BB.sentiment, location == "St. Louis")
atlanta <- subset(BB.sentiment, location == "Atlanta")
ny <- subset(BB.sentiment, location == "New York")
richmond <- subset(BB.sentiment, location == "Richmond")
sf <- subset(BB.sentiment, location == "San Francisco")
kc <- subset(BB.sentiment, location == "Kansas City")
minneapolis <- subset(BB.sentiment, location == "Minneapolis")
chicago <- subset(BB.sentiment, location == "Chicago")
boston <- subset(BB.sentiment, location == "Boston")
cleveland <- subset(BB.sentiment, location == "Cleveland")
phili <- subset(BB.sentiment, location == "Philadelphia")
```

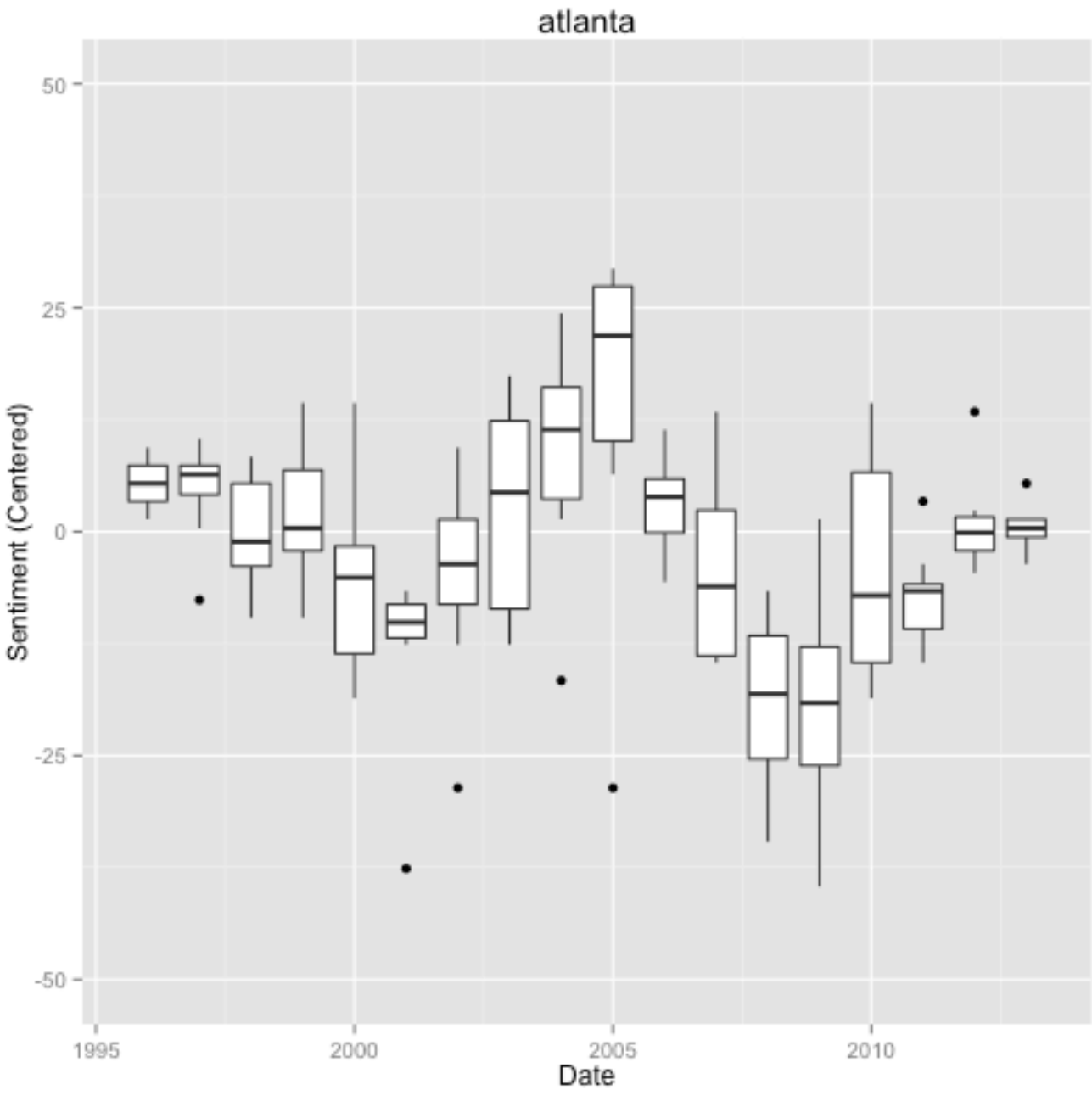
```
# BB.boxplot.dallas
BB.boxplot.dallas <- ggplot(dallas, aes(x = dallas$year, y = dallas$centered,
    group = dallas$year))
BB.boxplot.dallas <- BB.boxplot.dallas + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-70, 50)
BB.boxplot.dallas <- BB.boxplot.dallas + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("dallas")
# BB.boxplot.stlouis
BB.boxplot.stlouis <- ggplot(stlouis, aes(x = stlouis$year, y = stlouis$centered,
    group = stlouis$year))
BB.boxplot.stlouis <- BB.boxplot.stlouis + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.stlouis <- BB.boxplot.stlouis + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("stlouis")
# BB.boxplot.atlanta
BB.boxplot.atlanta <- ggplot(atlanta, aes(x = atlanta$year, y = atlanta$centered,
    group = atlanta$year))
BB.boxplot.atlanta <- BB.boxplot.atlanta + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.atlanta <- BB.boxplot.atlanta + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("atlanta")
# BB.boxplot.ny
BB.boxplot.ny <- ggplot(ny, aes(x = ny$year, y = ny$centered, group = ny$year))
BB.boxplot.ny <- BB.boxplot.ny + geom_boxplot(outlier.colour = "black",
outlier.shape = 16,
    outlier.size = 2) + ylim(-50, 50)
BB.boxplot.ny <- BB.boxplot.ny + xlab("Date") + ylab("Sentiment (Centered)") +
    ggtitle("ny")

BB.boxplot.dallas
```




```
BB.boxplot.stlouis
```

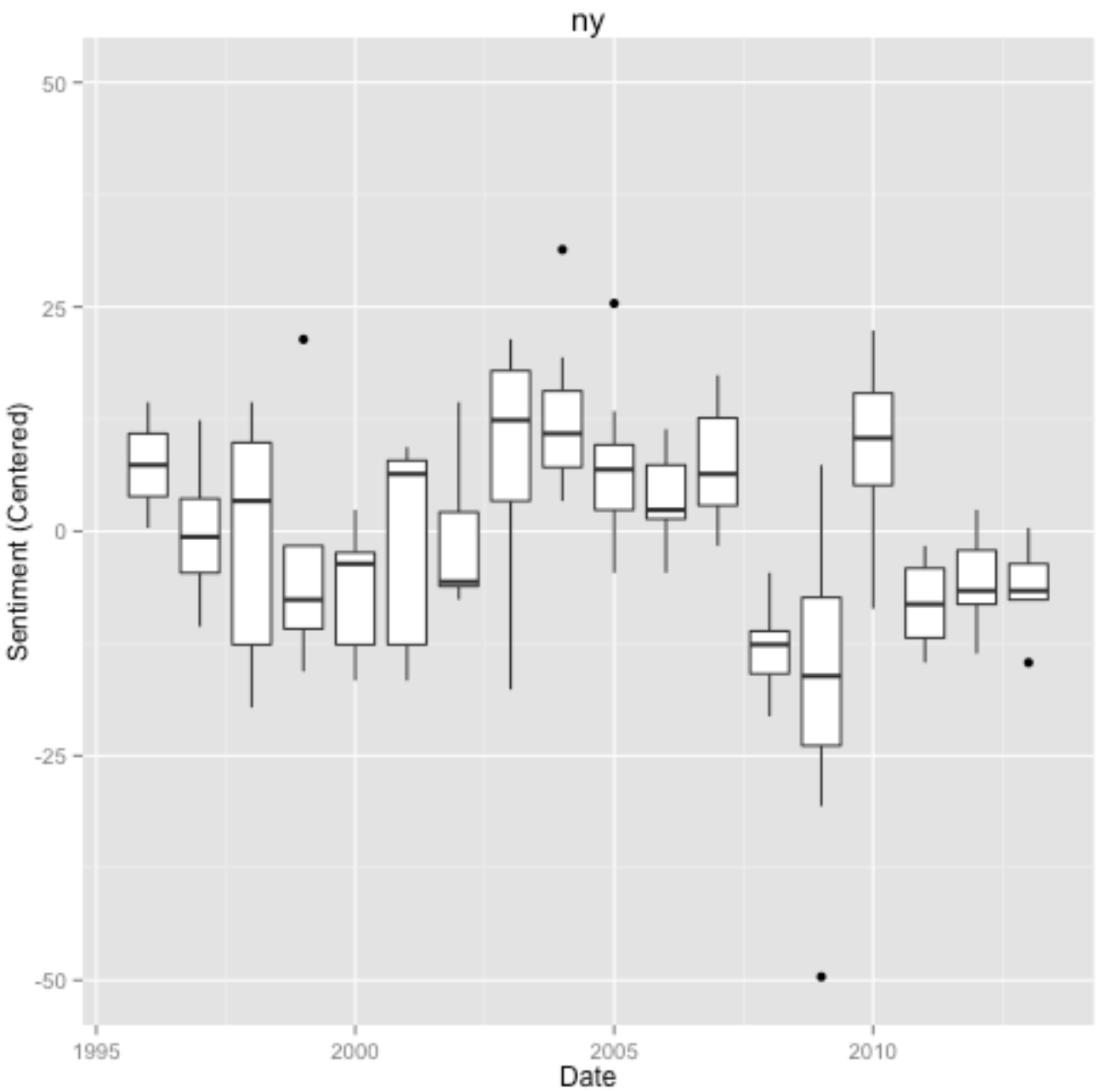


```
BB.boxplot.atlanta
```

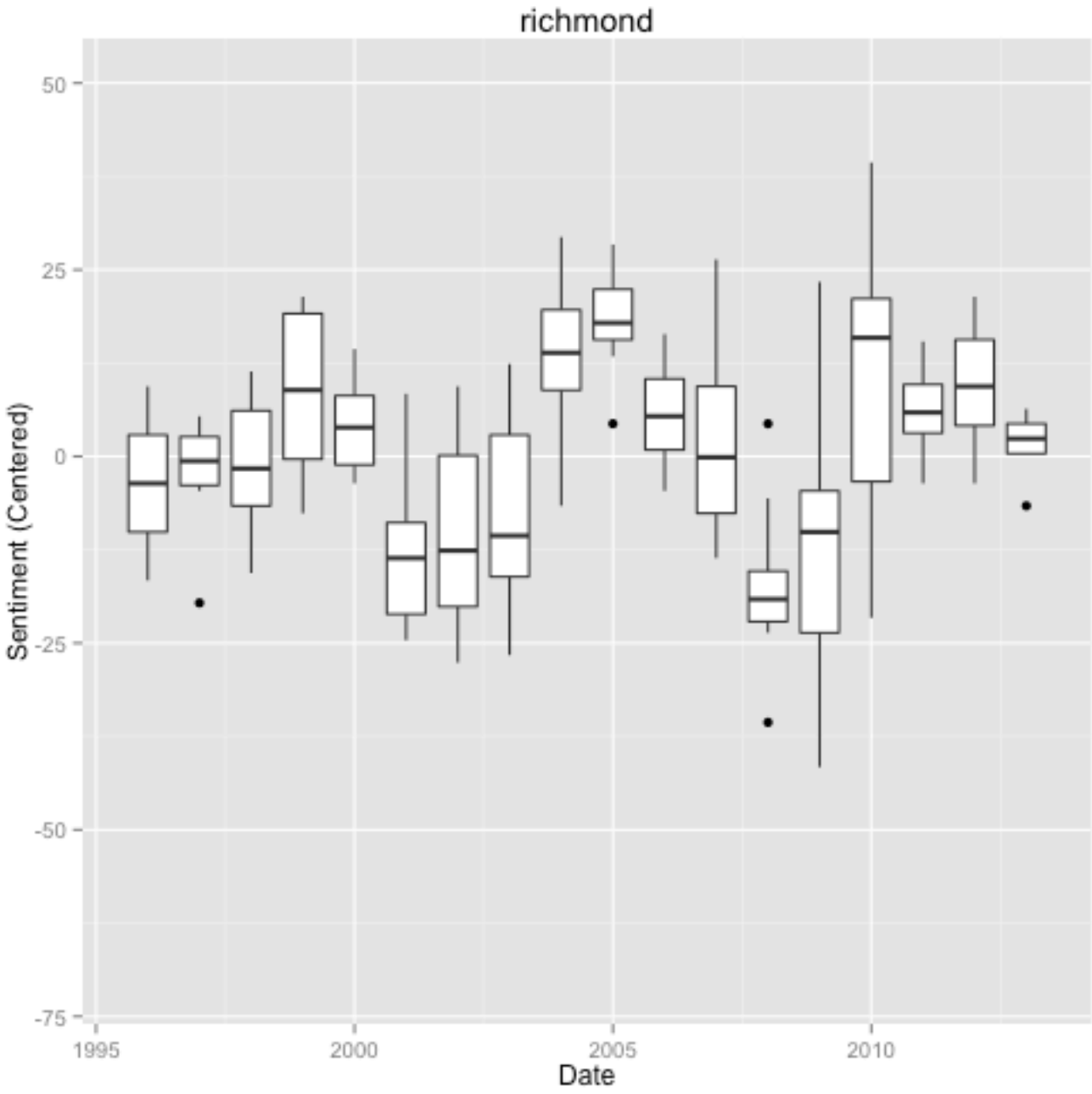



```
BB.boxplot.ny
```

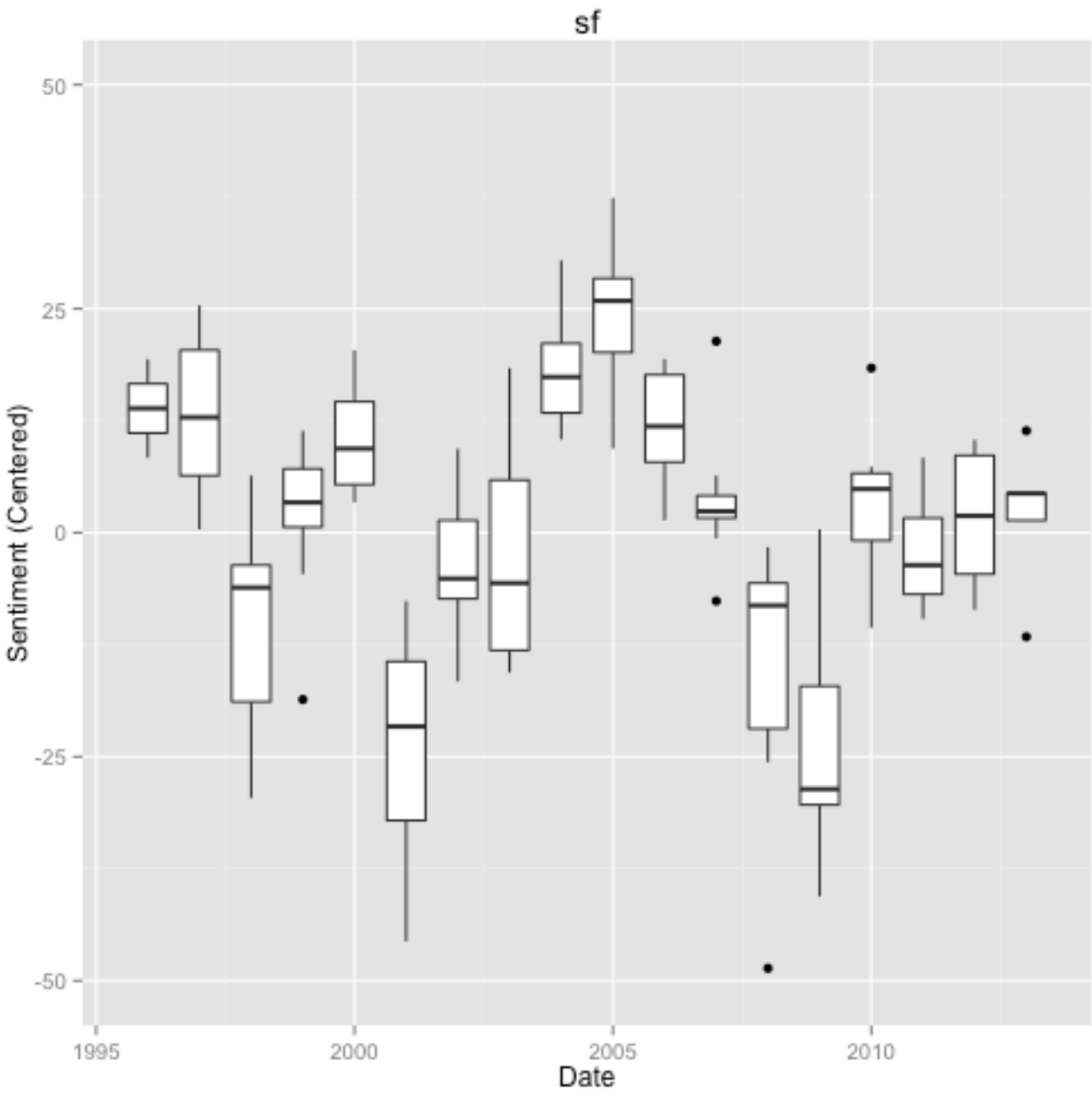
```
## Warning: Removed 1 rows containing non-finite values (stat_boxplot).
```


ny
50
25
0
-25
-50
Sentiment (Centered)
1995
2000
2005
2010
Date

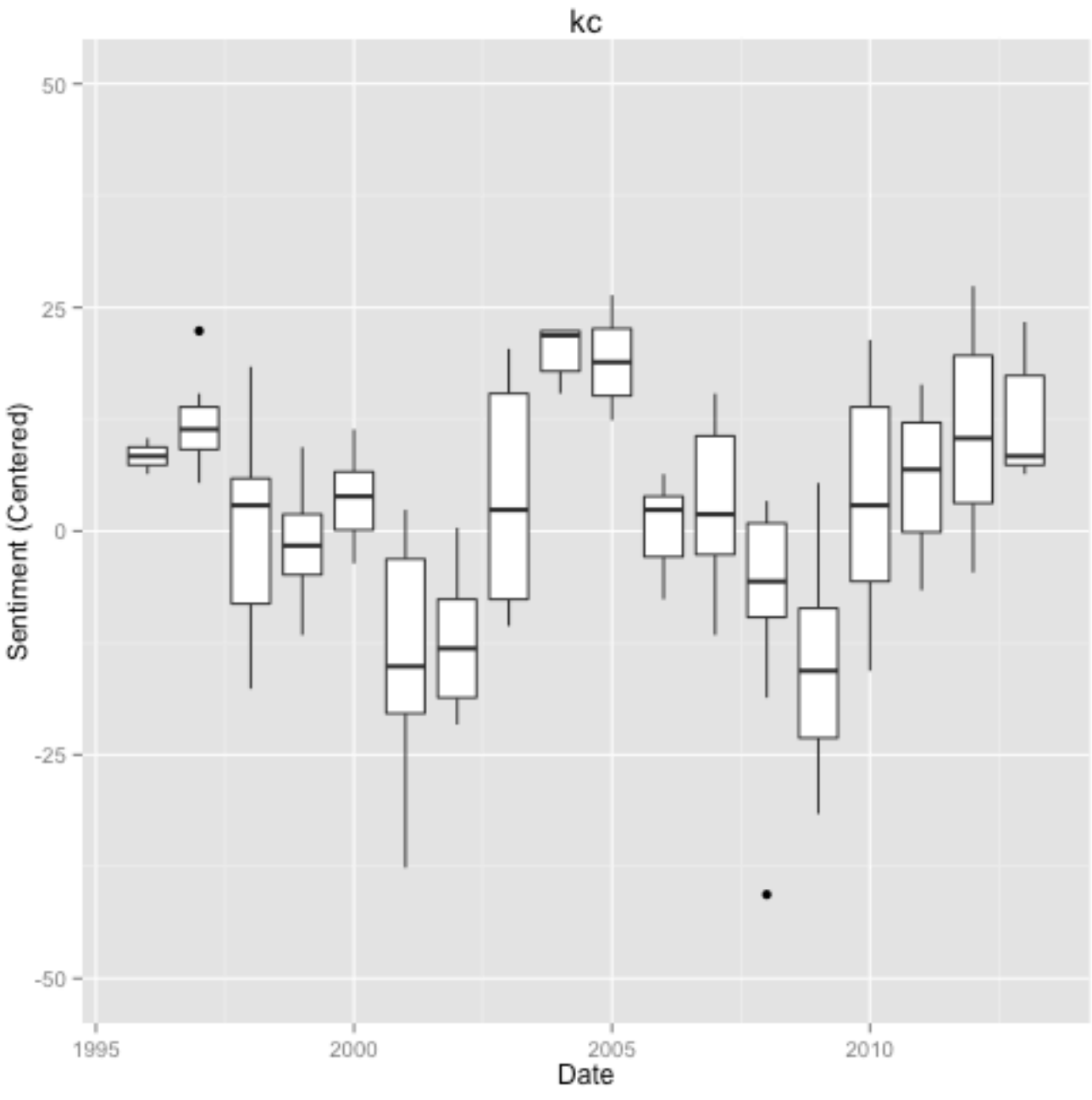
```
################# four plots (richmond, sf, kc, minneapolis)

# BB.boxplot.richmond
BB.boxplot.richmond <- ggplot(richmond, aes(x = richmond$year, y =
richmond$centered,
    group = richmond$year))
BB.boxplot.richmond <- BB.boxplot.richmond + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-70, 50)
BB.boxplot.richmond <- BB.boxplot.richmond + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("richmond")
# BB.boxplot.sf
BB.boxplot.sf <- ggplot(sf, aes(x = sf$year, y = sf$centered, group = sf$year))
BB.boxplot.sf <- BB.boxplot.sf + geom_boxplot(outlier.colour = "black",
outlier.shape = 16,
    outlier.size = 2) + ylim(-50, 50)
BB.boxplot.sf <- BB.boxplot.sf + xlab("Date") + ylab("Sentiment (Centered)") +
    ggtitle("sf")
# BB.boxplot.kc
BB.boxplot.kc <- ggplot(kc, aes(x = kc$year, y = kc$centered, group = kc$year))
BB.boxplot.kc <- BB.boxplot.kc + geom_boxplot(outlier.colour = "black",
outlier.shape = 16,
    outlier.size = 2) + ylim(-50, 50)
BB.boxplot.kc <- BB.boxplot.kc + xlab("Date") + ylab("Sentiment (Centered)") +
    ggtitle("kc")
# BB.boxplot.minneapolis
BB.boxplot.minneapolis <- ggplot(minneapolis, aes(x = minneapolis$year, y =
minneapolis$centered,
    group = minneapolis$year))
BB.boxplot.minneapolis <- BB.boxplot.minneapolis + geom_boxplot(outlier.colour =
"black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.minneapolis <- BB.boxplot.minneapolis + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("minneapolis")

BB.boxplot.richmond
```



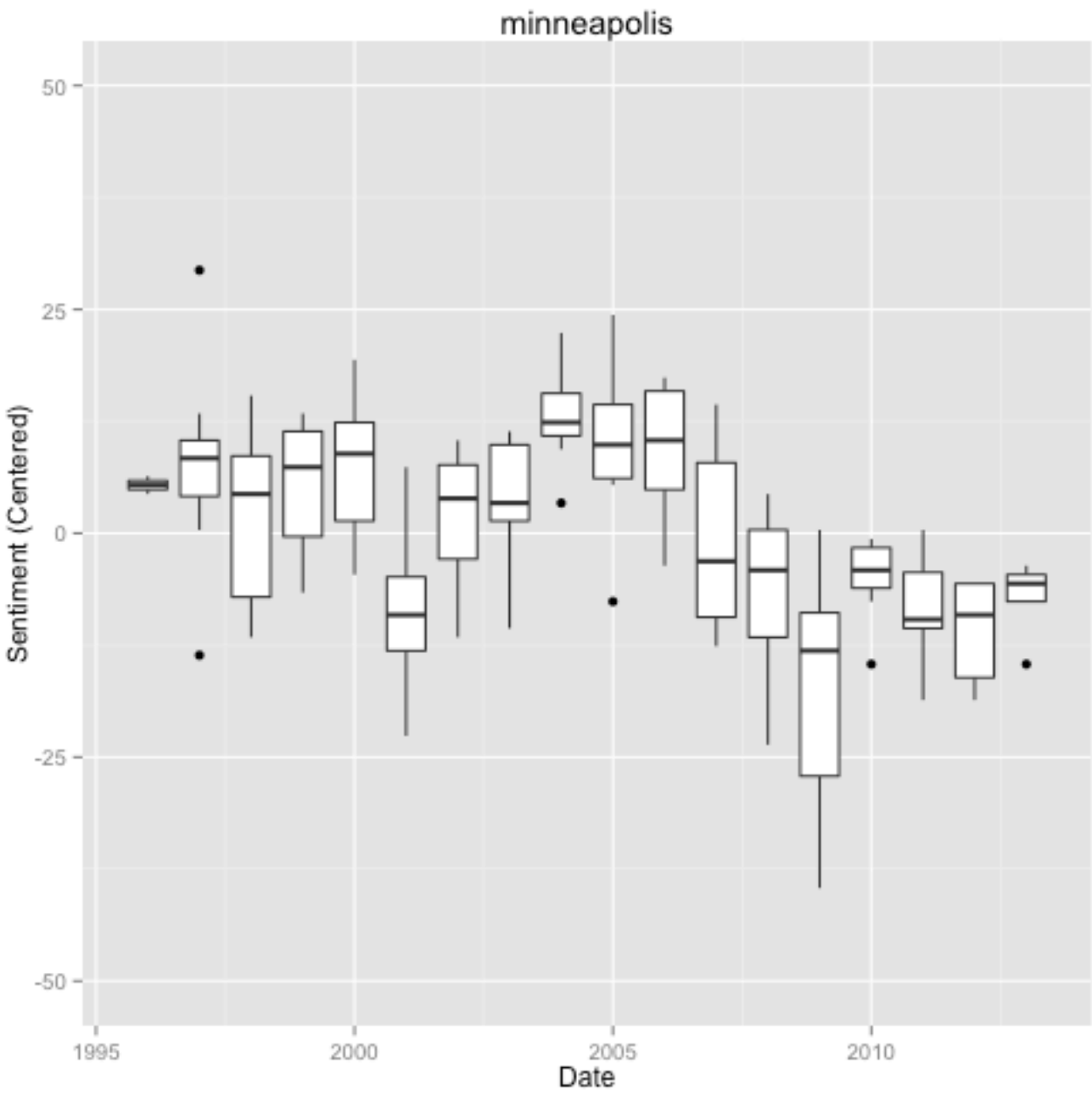

```
BB.boxplot.sf
```



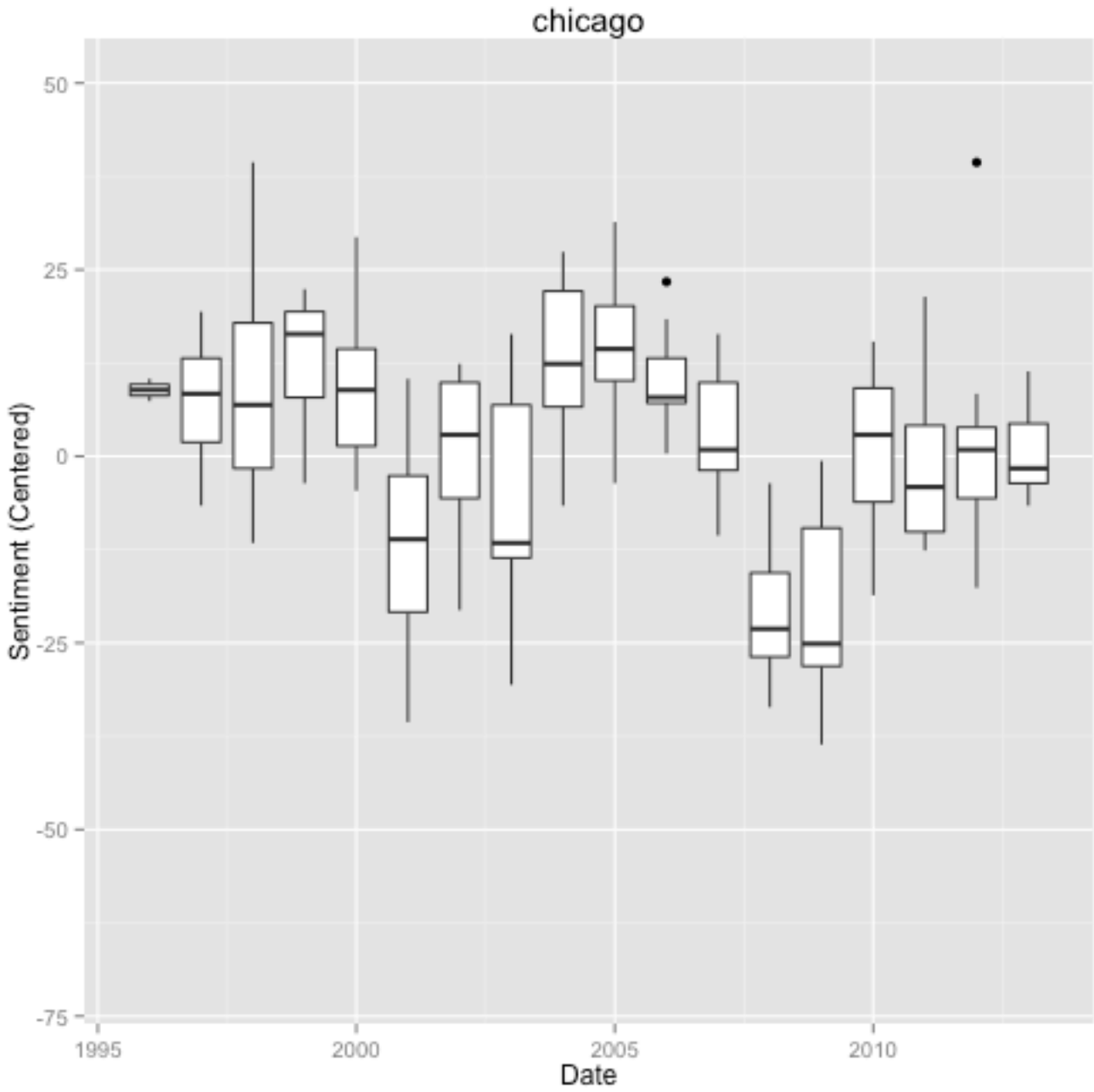
```
BB.boxplot.kc
```



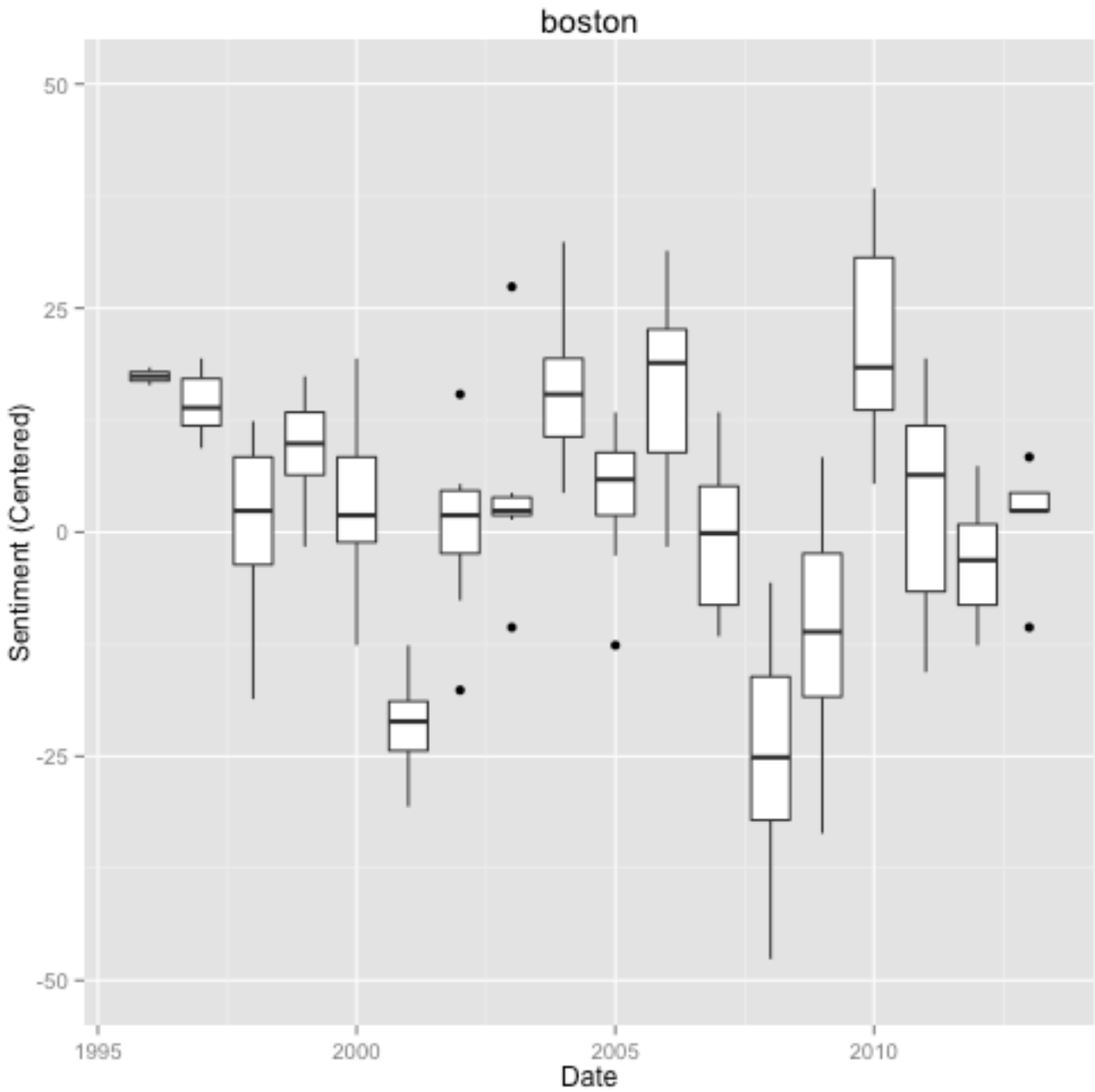

```
BB.boxplot.minneapolis
```


minneapolis
50
25
0
-25
-50
Sentiment (Centered)
1995
2000
2005
2010
Date

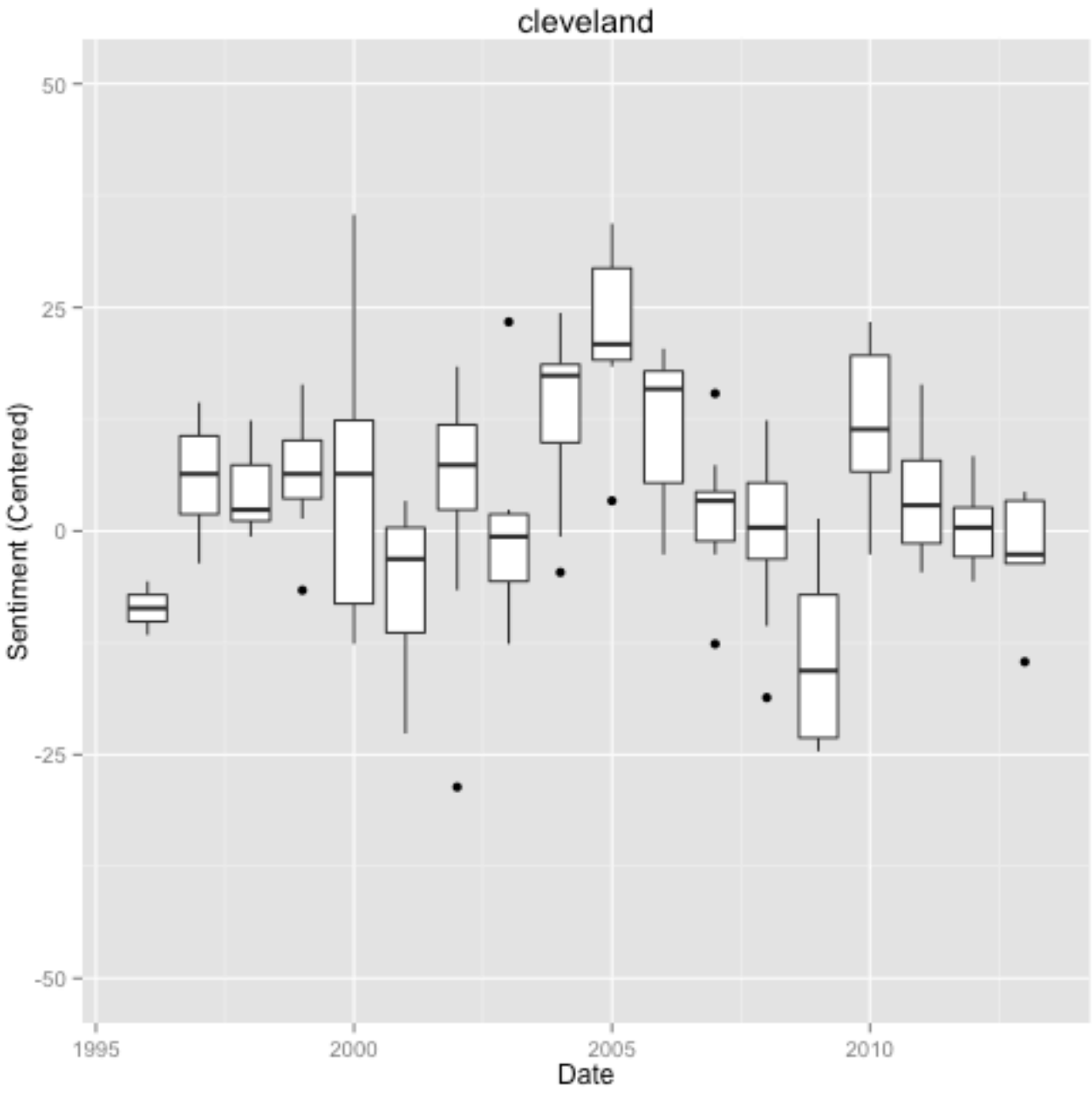
```
################## four plots (chicago, boston, cleveland, phili)

# BB.boxplot.chicago
BB.boxplot.chicago <- ggplot(chicago, aes(x = chicago$year, y = chicago$centered,
    group = chicago$year))
BB.boxplot.chicago <- BB.boxplot.chicago + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-70, 50)
BB.boxplot.chicago <- BB.boxplot.chicago + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("chicago")
# BB.boxplot.boston
BB.boxplot.boston <- ggplot(boston, aes(x = boston$year, y = boston$centered,
    group = boston$year))
BB.boxplot.boston <- BB.boxplot.boston + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.boston <- BB.boxplot.boston + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("boston")
# BB.boxplot.cleveland
BB.boxplot.cleveland <- ggplot(cleveland, aes(x = cleveland$year, y =
cleveland$centered,
    group = cleveland$year))
BB.boxplot.cleveland <- BB.boxplot.cleveland + geom_boxplot(outlier.colour =
"black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.cleveland <- BB.boxplot.cleveland + xlab("Date") + ylab("Sentiment
(Centered)") +
    ggtitle("cleveland")
# BB.boxplot.phili
BB.boxplot.phili <- ggplot(phili, aes(x = phili$year, y = phili$centered, group =
phili$year))
BB.boxplot.phili <- BB.boxplot.phili + geom_boxplot(outlier.colour = "black",
    outlier.shape = 16, outlier.size = 2) + ylim(-50, 50)
BB.boxplot.phili <- BB.boxplot.phili + xlab("Date") + ylab("Sentiment (Centered)")
+
    ggtitle("phili")

BB.boxplot.chicago
```



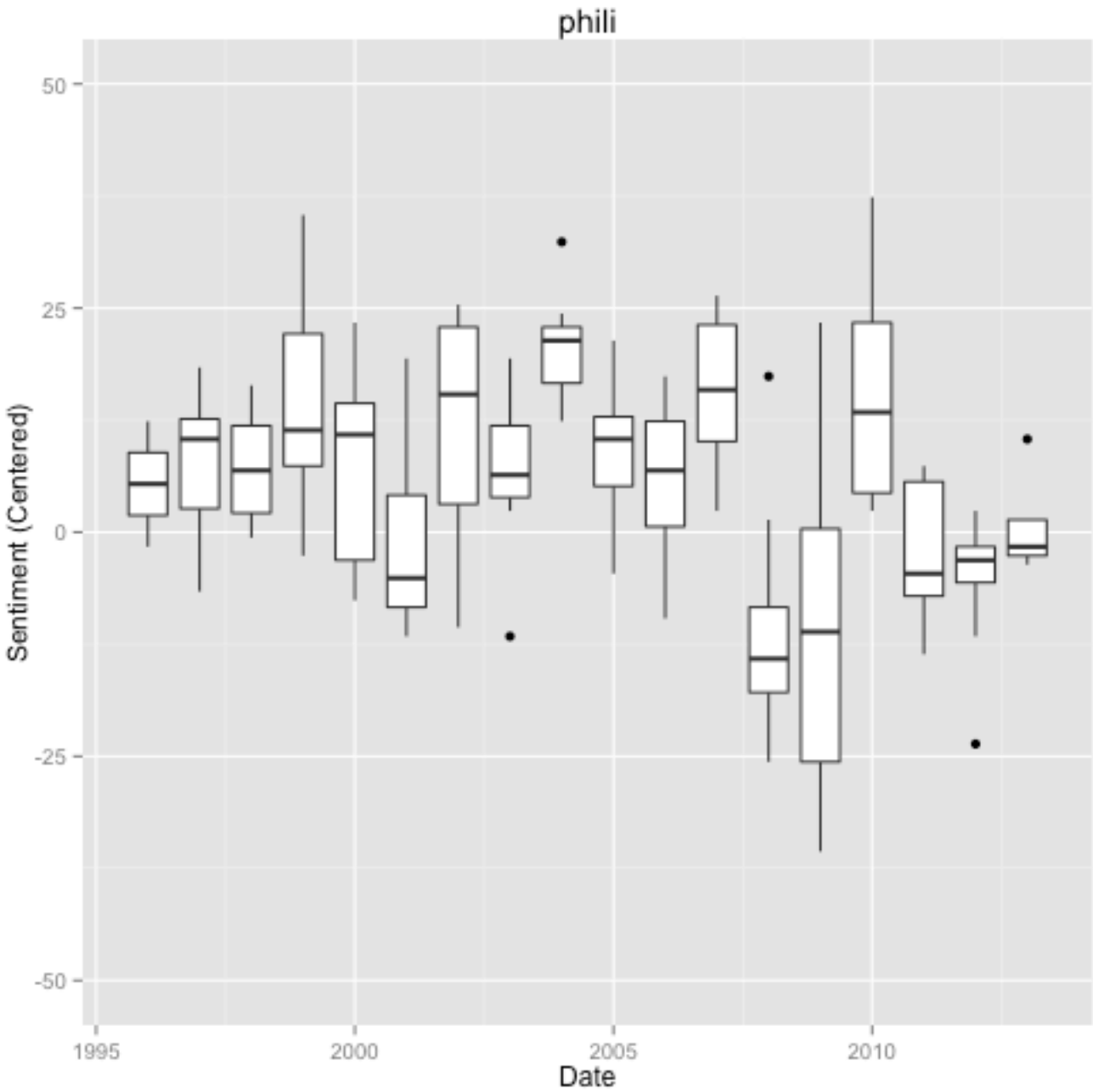

```
BB.boxplot.boston
```



```
BB.boxplot.cleveland
```

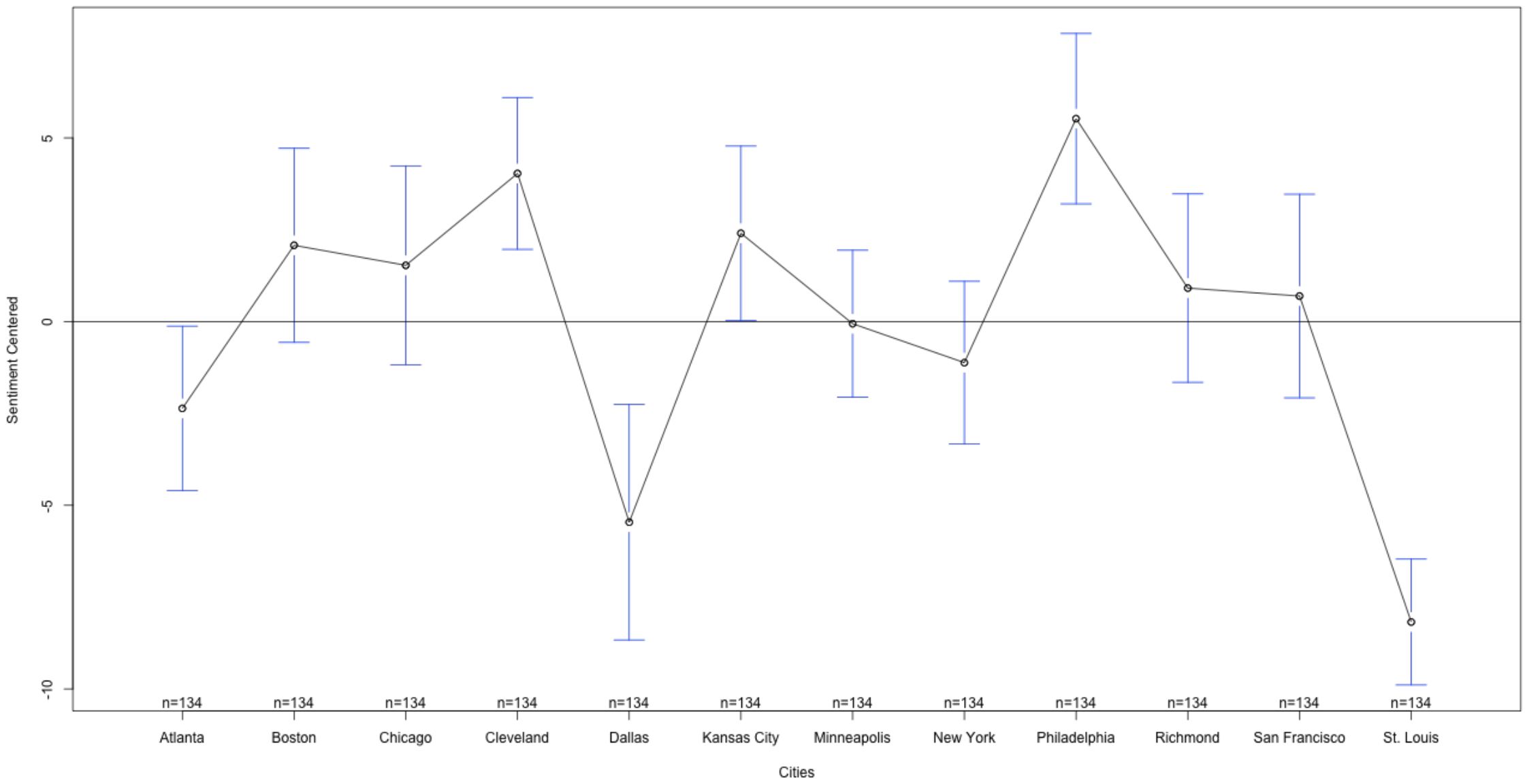



```
BB.boxplot.phili
```



Distributions are skewed, there are outliers, and homogeneity is out the window!

```
# plot group means and confidence intervals requires {gplots}
plotmeans(BB.sentiment$centered ~ BB.sentiment$location, xlab = "Cities", ylab =
"Sentiment Centered",
    main = "Mean Plot with 95% CI") + abline(h = 0)
```




```
## numeric(0)
```

```
# oneway.test tests whether multiples samples have the same means; variances
# are not necessarily assumed to be equal.  gives same results as anova(lm(y
# ~ x, data = data))
bb.oneway <- oneway.test(BB.sentiment$score ~ BB.sentiment$location, data =
BB.sentiment)
bb.aov <- aov(BB.sentiment$score ~ BB.sentiment$location, data = BB.sentiment)
```

```
summary(bb.oneway)
```

```
##           Length Class  Mode
## statistic 1      -none- numeric
## parameter 2      -none- numeric
## p.value   1      -none- numeric
## method    1      -none- character
## data.name 1      -none- character
```

```
summary(bb.aov)
```

```
##                         Df Sum Sq Mean Sq F value Pr(>F)
## BB.sentiment$location   11  21984    1999    9.86 <2e-16 ***
## Residuals             1596 323432     203
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
TukeyHSD(bb.aov)
```

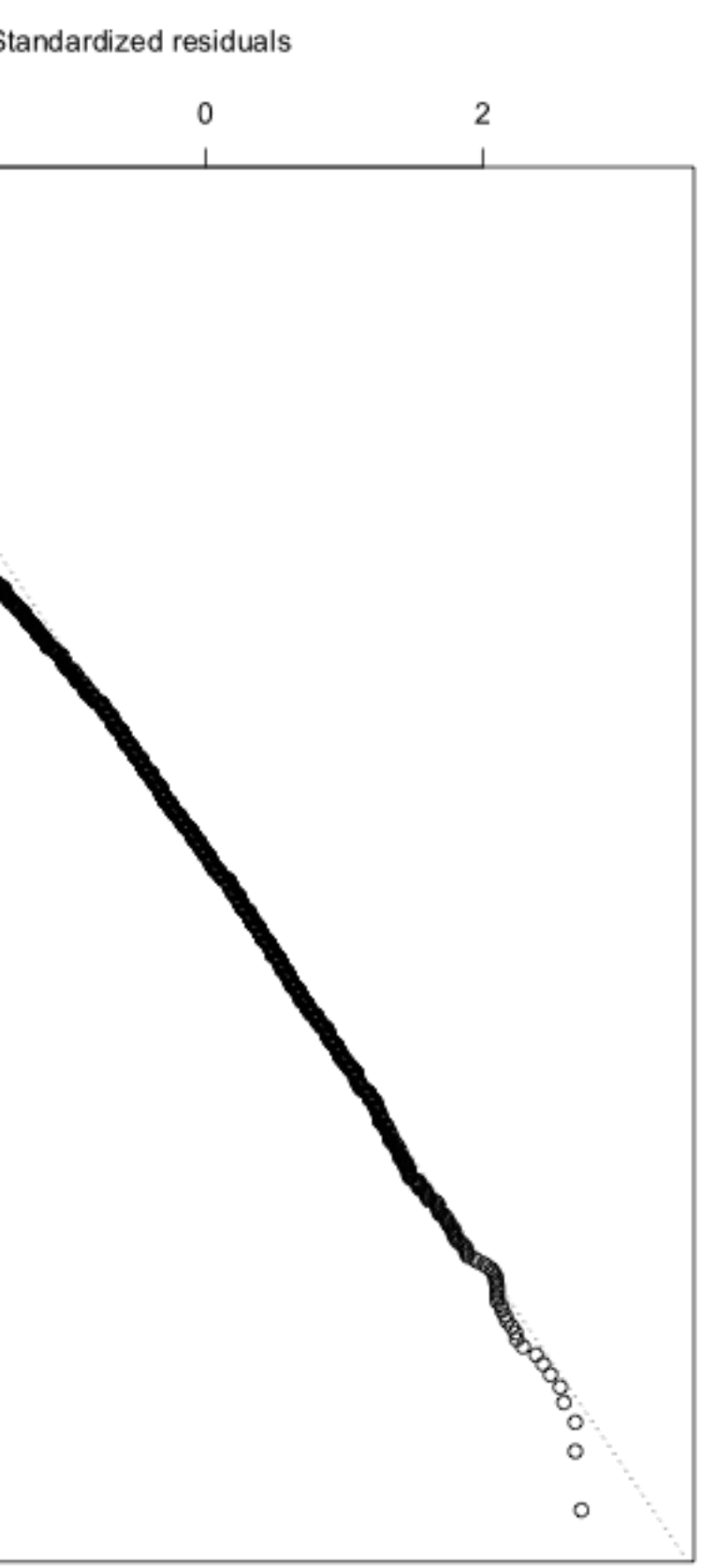
```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = BB.sentiment$score ~ BB.sentiment$location, data =
BB.sentiment)
##
## $`BB.sentiment$location`
##                                diff      lwr     upr  p adj
## Boston-Atlanta                4.4403  -1.2518 10.1324 0.3078
## Chicago-Atlanta               3.8955  -1.7966  9.5876 0.5206
## Cleveland-Atlanta             6.3955   0.7034 12.0876 0.0130
## Dallas-Atlanta               -3.0970  -8.7891  2.5951 0.8285
## Kansas City-Atlanta           4.7687  -0.9234 10.4607 0.2068
## Minneapolis-Atlanta           2.3060  -3.3861  7.9980 0.9758
## New York-Atlanta              1.2463  -4.4458  6.9383 0.9999
## Philadelphia-Atlanta          7.8881   2.1960 13.5801 0.0004
## Richmond-Atlanta              3.2761  -2.4160  8.9682 0.7695
## San Francisco-Atlanta         3.0597  -2.6324  8.7518 0.8397
## St. Louis-Atlanta            -5.8134 -11.5055 -0.1214 0.0402
## Chicago-Boston               -0.5448  -6.2369  5.1473 1.0000
## Cleveland-Boston              1.9552  -3.7369  7.6473 0.9936
## Dallas-Boston                -7.5373 -13.2294 -1.8452 0.0009
## Kansas City-Boston            0.3284  -5.3637  6.0204 1.0000
## Minneapolis-Boston           -2.1343  -7.8264  3.5577 0.9868
## New York-Boston              -3.1940  -8.8861  2.4980 0.7976
## Philadelphia-Boston           3.4478  -2.2443  9.1398 0.7055
## Richmond-Boston              -1.1642  -6.8563  4.5279 1.0000
## San Francisco-Boston         -1.3806  -7.0727  4.3115 0.9997
## St. Louis-Boston            -10.2537 -15.9458 -4.5617 0.0000
## Cleveland-Chicago             2.5000  -3.1921  8.1921 0.9560
## Dallas-Chicago               -6.9925 -12.6846 -1.3005 0.0035
## Kansas City-Chicago           0.8731  -4.8189  6.5652 1.0000
## Minneapolis-Chicago          -1.5896  -7.2816  4.1025 0.9990
## New York-Chicago             -2.6493  -8.3413  3.0428 0.9343
## Philadelphia-Chicago          3.9925  -1.6995  9.6846 0.4801
## Richmond-Chicago             -0.6194  -6.3115  5.0727 1.0000
## San Francisco-Chicago        -0.8358  -6.5279  4.8563 1.0000
## St. Louis-Chicago            -9.7090 -15.4010 -4.0169 0.0000
## Dallas-Cleveland             -9.4925 -15.1846 -3.8005 0.0000
## Kansas City-Cleveland        -1.6269  -7.3189  4.0652 0.9988
## Minneapolis-Cleveland        -4.0896  -9.7816  1.6025 0.4403
## New York-Cleveland           -5.1493 -10.8413  0.5428 0.1213
## Philadelphia-Cleveland        1.4925  -4.1995  7.1846 0.9994
## Richmond-Cleveland           -3.1194  -8.8115  2.5727 0.8216
## San Francisco-Cleveland      -3.3358  -9.0279  2.3563 0.7479
## St. Louis-Cleveland         -12.2090 -17.9010 -6.5169 0.0000
## Kansas City-Dallas            7.8657   2.1736 13.5577 0.0004
## Minneapolis-Dallas            5.4030  -0.2891 11.0951 0.0816
## New York-Dallas               4.3433  -1.3488 10.0354 0.3422
```

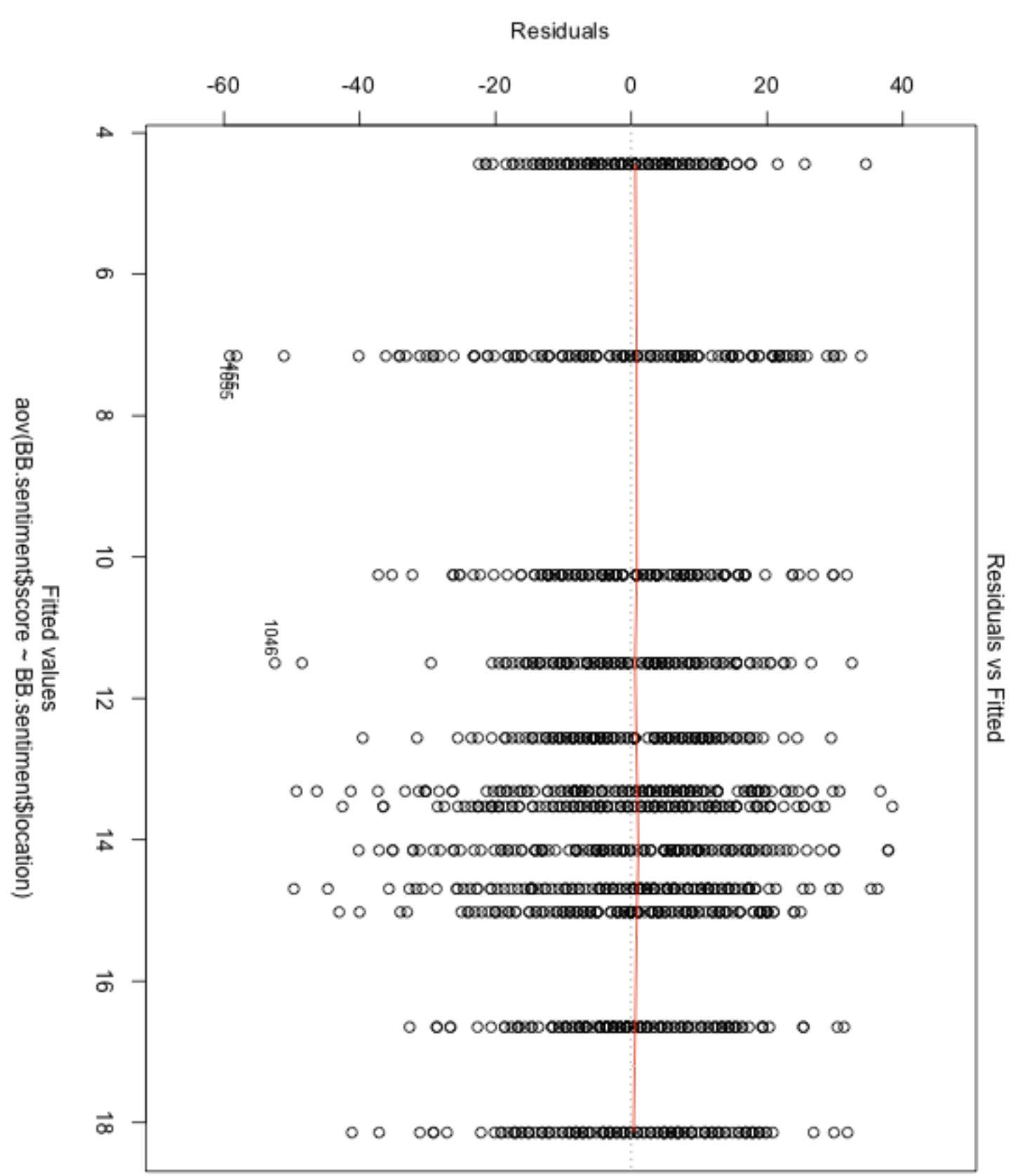
```
## Philadelphia-Dallas          10.9851   5.2930 16.6772 0.0000
## Richmond-Dallas               6.3731   0.6811 12.0652 0.0136
## San Francisco-Dallas          6.1567   0.4646 11.8488 0.0210
## St. Louis-Dallas             -2.7164  -8.4085  2.9757 0.9224
## Minneapolis-Kansas City      -2.4627  -8.1548  3.2294 0.9605
## New York-Kansas City         -3.5224  -9.2145  2.1697 0.6760
## Philadelphia-Kansas City      3.1194  -2.5727  8.8115 0.8216
## Richmond-Kansas City         -1.4925  -7.1846  4.1995 0.9994
## San Francisco-Kansas City    -1.7090  -7.4010  3.9831 0.9980
## St. Louis-Kansas City       -10.5821 -16.2742 -4.8900 0.0000
## New York-Minneapolis         -1.0597  -6.7518  4.6324 1.0000
## Philadelphia-Minneapolis      5.5821  -0.1100 11.2742 0.0605
## Richmond-Minneapolis          0.9701  -4.7219  6.6622 1.0000
## San Francisco-Minneapolis     0.7537  -4.9383  6.4458 1.0000
## St. Louis-Minneapolis        -8.1194 -13.8115 -2.4273 0.0002
## Philadelphia-New York         6.6418   0.9497 12.3339 0.0077
## Richmond-New York             2.0299  -3.6622  7.7219 0.9913
## San Francisco-New York        1.8134  -3.8786  7.5055 0.9967
## St. Louis-New York           -7.0597 -12.7518 -1.3676 0.0030
## Richmond-Philadelphia        -4.6119 -10.3040  1.0801 0.2518
## San Francisco-Philadelphia   -4.8284 -10.5204  0.8637 0.1911
## St. Louis-Philadelphia      -13.7015 -19.3936 -8.0094 0.0000
## San Francisco-Richmond       -0.2164  -5.9085  5.4757 1.0000
## St. Louis-Richmond           -9.0896 -14.7816 -3.3975 0.0000
## St. Louis-San Francisco      -8.8731 -14.5652 -3.1811 0.0000
```

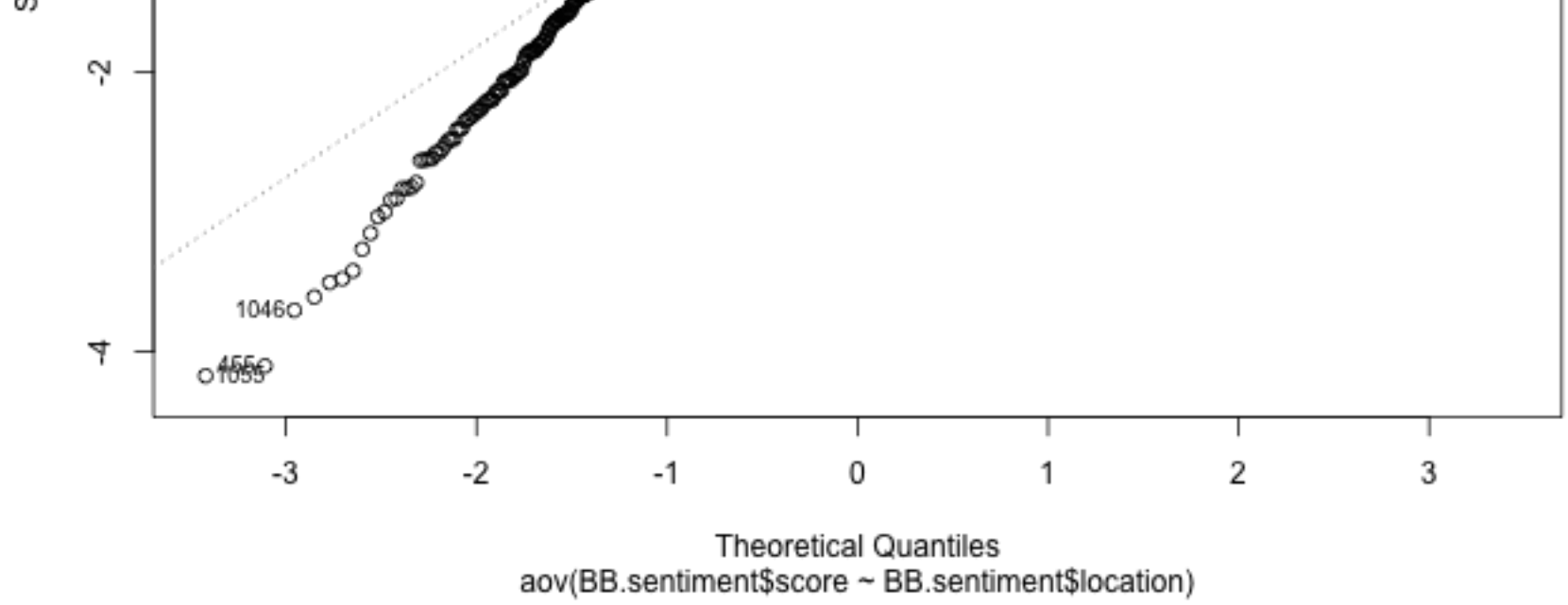
```
summary.lm(bb.aov)
```

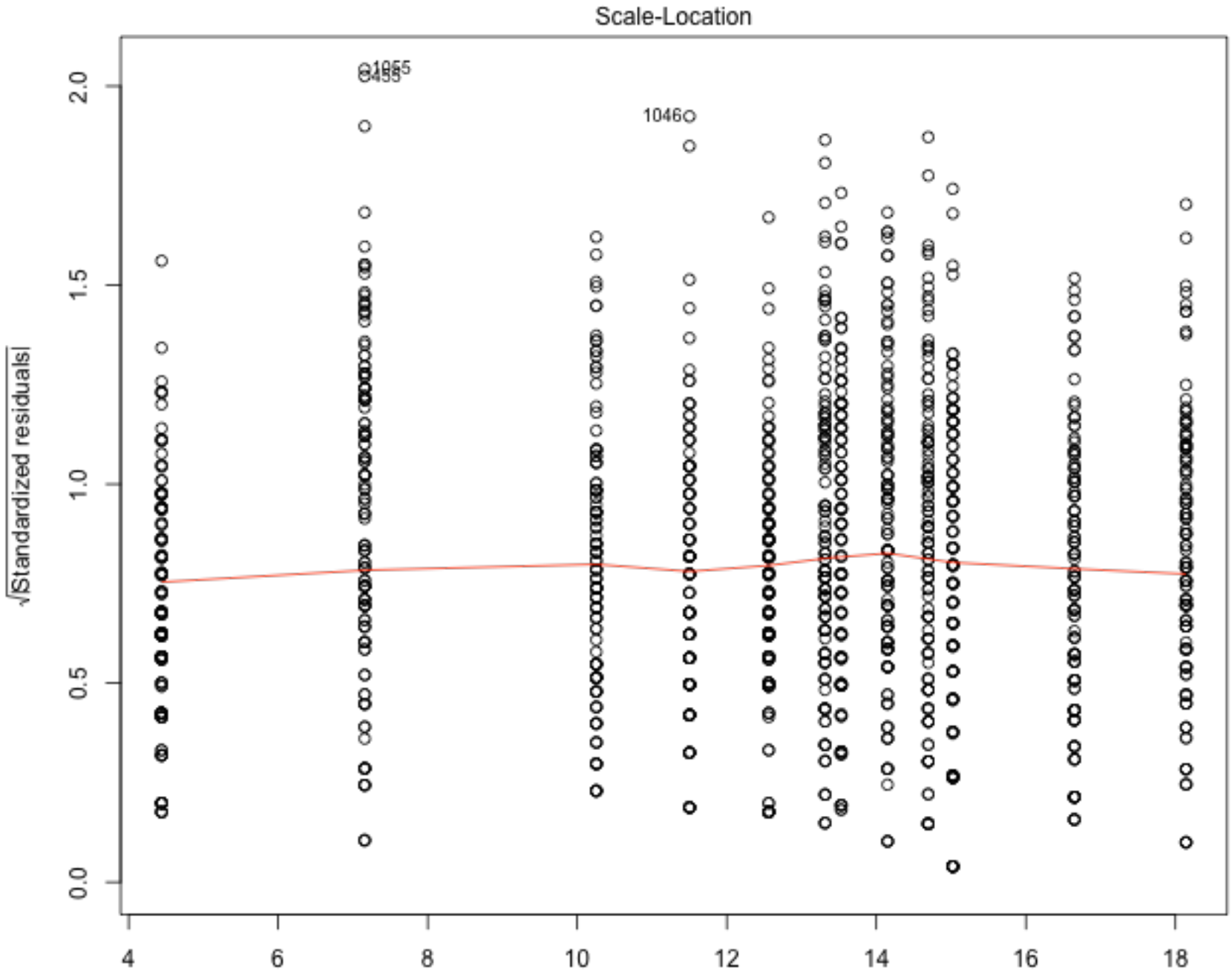
```
##
## Call:
## aov(formula = BB.sentiment$score ~ BB.sentiment$location, data = BB.sentiment)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -59.16  -8.31   0.72   9.50  38.47
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                        10.25       1.23    8.34  < 2e-16
## BB.sentiment$locationBoston         4.44       1.74    2.55  0.01077
## BB.sentiment$locationChicago        3.90       1.74    2.24  0.02523
## BB.sentiment$locationCleveland      6.40       1.74    3.68  0.00024
## BB.sentiment$locationDallas        -3.10       1.74   -1.78  0.07514
## BB.sentiment$locationKansas City    4.77       1.74    2.74  0.00618
## BB.sentiment$locationMinneapolis    2.31       1.74    1.33  0.18506
## BB.sentiment$locationNew York       1.25       1.74    0.72  0.47373
## BB.sentiment$locationPhiladelphia   7.89       1.74    4.54  6.2e-06
## BB.sentiment$locationRichmond       3.28       1.74    1.88  0.05978
## BB.sentiment$locationSan Francisco  3.06       1.74    1.76  0.07872
## BB.sentiment$locationSt. Louis     -5.81       1.74   -3.34  0.00085
##
## (Intercept)                        ***
## BB.sentiment$locationBoston        *
## BB.sentiment$locationChicago       *
## BB.sentiment$locationCleveland     ***
## BB.sentiment$locationDallas        .
## BB.sentiment$locationKansas City   **
## BB.sentiment$locationMinneapolis
## BB.sentiment$locationNew York
## BB.sentiment$locationPhiladelphia  ***
## BB.sentiment$locationRichmond      .
## BB.sentiment$locationSan Francisco .
## BB.sentiment$locationSt. Louis     ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14.2 on 1596 degrees of freedom
## Multiple R-squared:  0.0636, Adjusted R-squared:  0.0572
## F-statistic: 9.86 on 11 and 1596 DF,  p-value: <2e-16
```

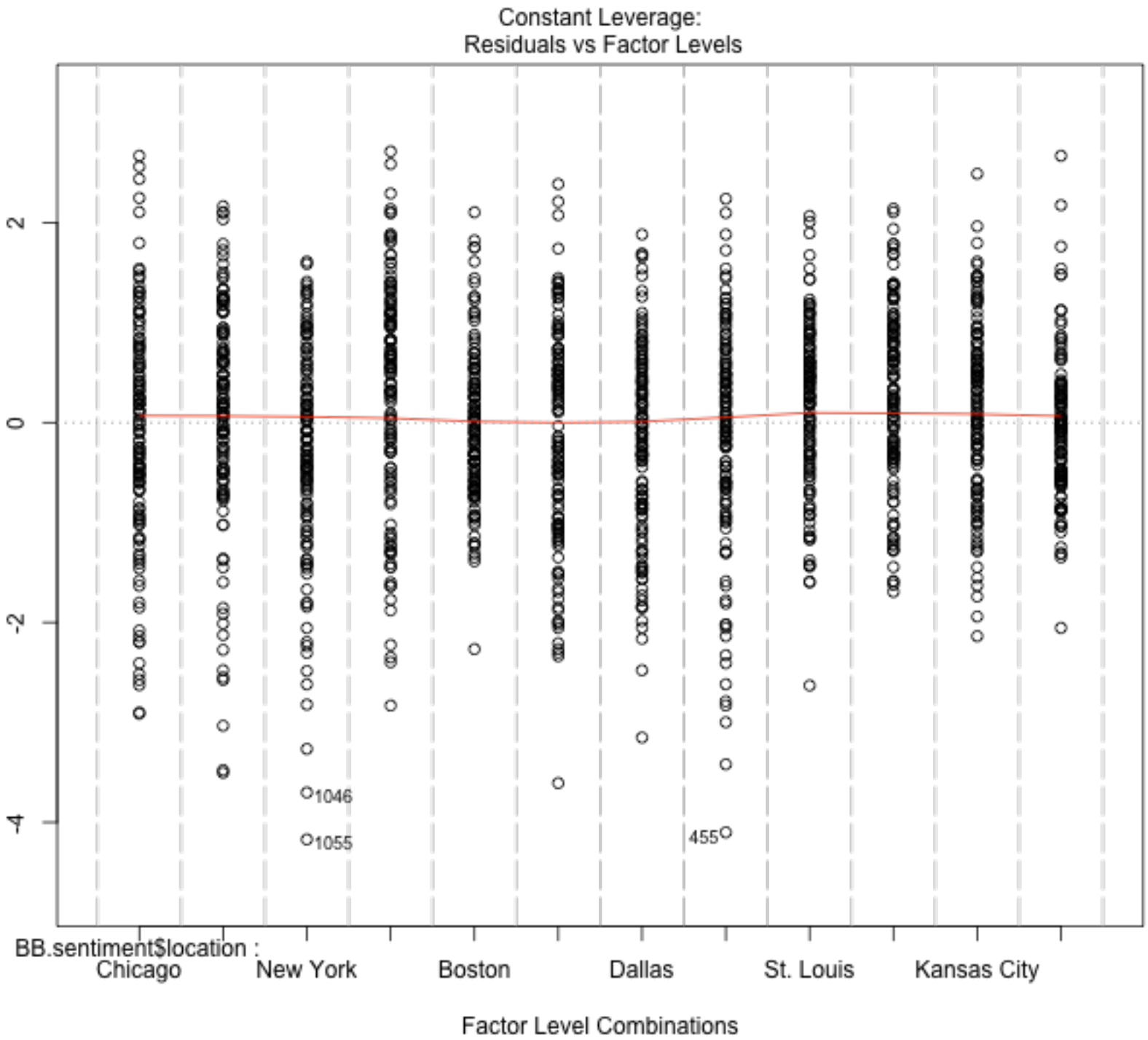
```
plot(bb.aov)
```


Standardized residuals
0
2
Normal Q-Q


Residuals
-60
-40
-20
0
20
40
Residuals vs Fitted
Fitted values
aov(BB.sentiment$score ~ BB.sentiment$location)
4
6
8
10
12
14
16
18
4855
1046


-2
-4
1046
455
1055
-3
-2
-1
0
1
2
3
Theoretical Quantiles
aov(BB.sentiment$score ~ BB.sentiment$location)


Scale-Location
√|Standardized residuals|
2.0
1.5
1.0
0.5
0.0
1055
455
1046
4
6
8
10
12
14
16
18
Fitted values
aov(BB.sentiment$score ~ BB.sentiment$location)


Constant Leverage:
Residuals vs Factor Levels
Standardized residuals
2
0
-2
-4
1046
1055
455
BB.sentiment$location :
Chicago
New York
Boston
Dallas
St. Louis
Kansas City
Factor Level Combinations