Exploratory Graphs

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Why do we use graphs in data analysis?

- To understand data properties
- To find patterns in data
- To suggest modeling strategies
- To "debug" analyses
- To communicate results

Exploratory graphs

- To understand data properties
- To find patterns in data
- To suggest modeling strategies
- To "debug" analyses
- To communicate results

Characteristics of exploratory graphs

- They are made quickly
- A large number are made
- The goal is for personal understanding
- Axes/legends are generally cleaned up (later)
- Color/size are primarily used for information

Air Pollution in the United States

- The U.S. Environmental Protection Agency (EPA) sets national ambient air quality standards for outdoor air pollution

- U.S. National Ambient Air Quality Standards

- For fine particle pollution (PM2.5), the "annual mean, averaged over 3 years" cannot exceed 12 $\mu g/m^3$.

- Data on daily PM2.5 are available from the U.S. EPA web site

- EPA Air Quality System

- **Question**: Are there any counties in the U.S. that exceed that national standard for fine particle pollution?

Data

Annual average PM2.5 averaged over the period 2008 through 2010

```
pollution <- read.csv("data/avgpm25.csv", colClasses = c("numeric", "character", "factor", "numeric", "n
head(pollution)
```

```
##        pm25  fips region longitude latitude
## 1  9.771185 01003   east -87.74826 30.59278
## 2  9.993817 01027   east -85.84286 33.26581
## 3 10.688618 01033   east -87.72596 34.73148
## 4 11.337424 01049   east -85.79892 34.45913
## 5 12.119764 01055   east -86.03212 34.01860
## 6 10.827805 01069   east -85.35039 31.18973
```

Do any counties exceed the standard of 12 $\mu g/m^3$?

Simple Summaries of Data

One dimension

- Five-number summary
- Boxplots
- Histograms
- Density plot
- Barplot

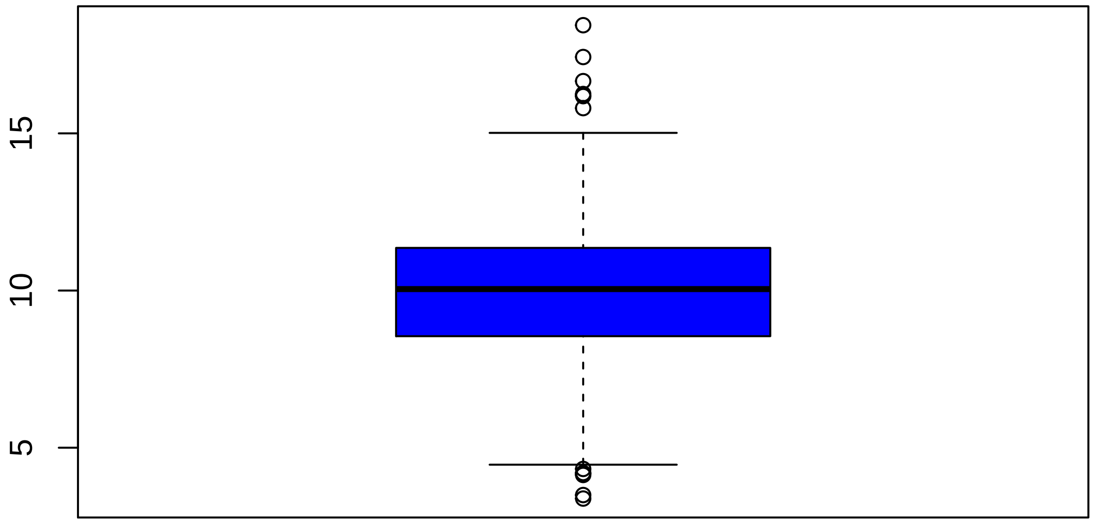
Five Number Summary

```
summary(pollution$pm25)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   3.383   8.549  10.050   9.836  11.360  18.440
```

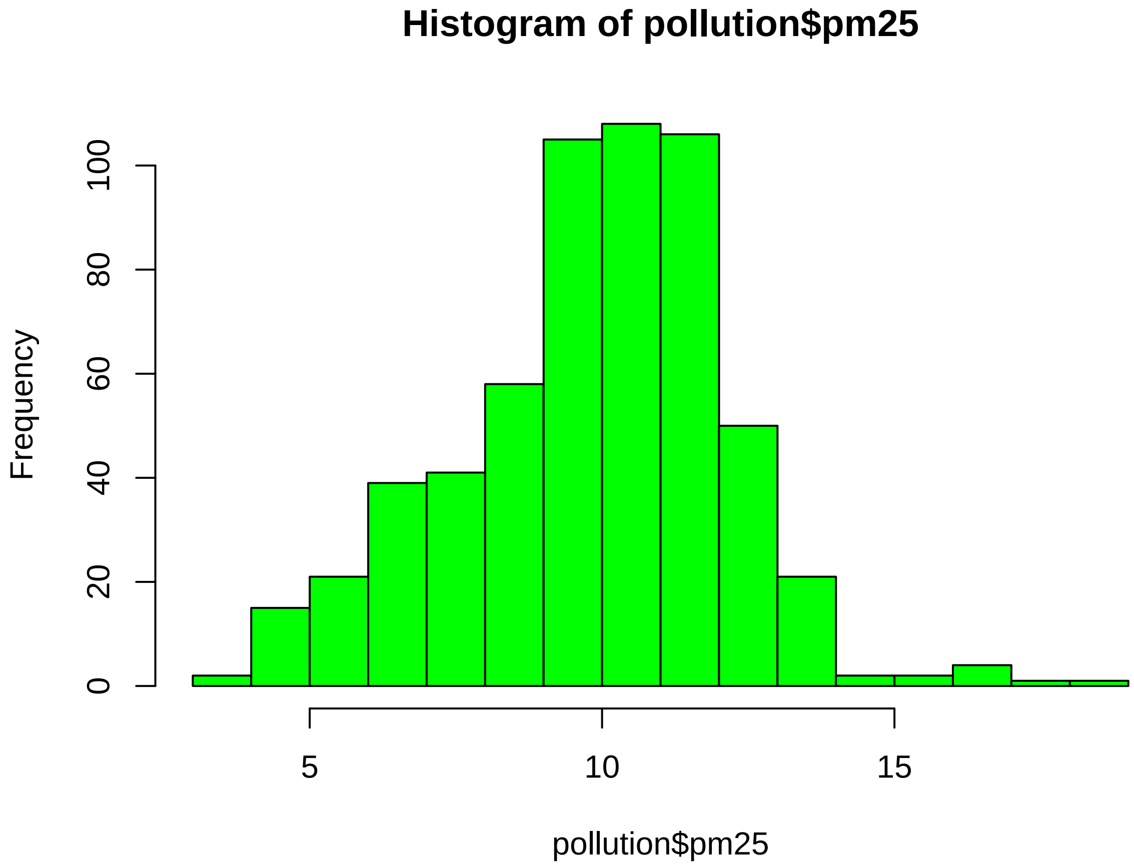
Boxplot

```
boxplot(pollution$pm25, col = "blue")
```



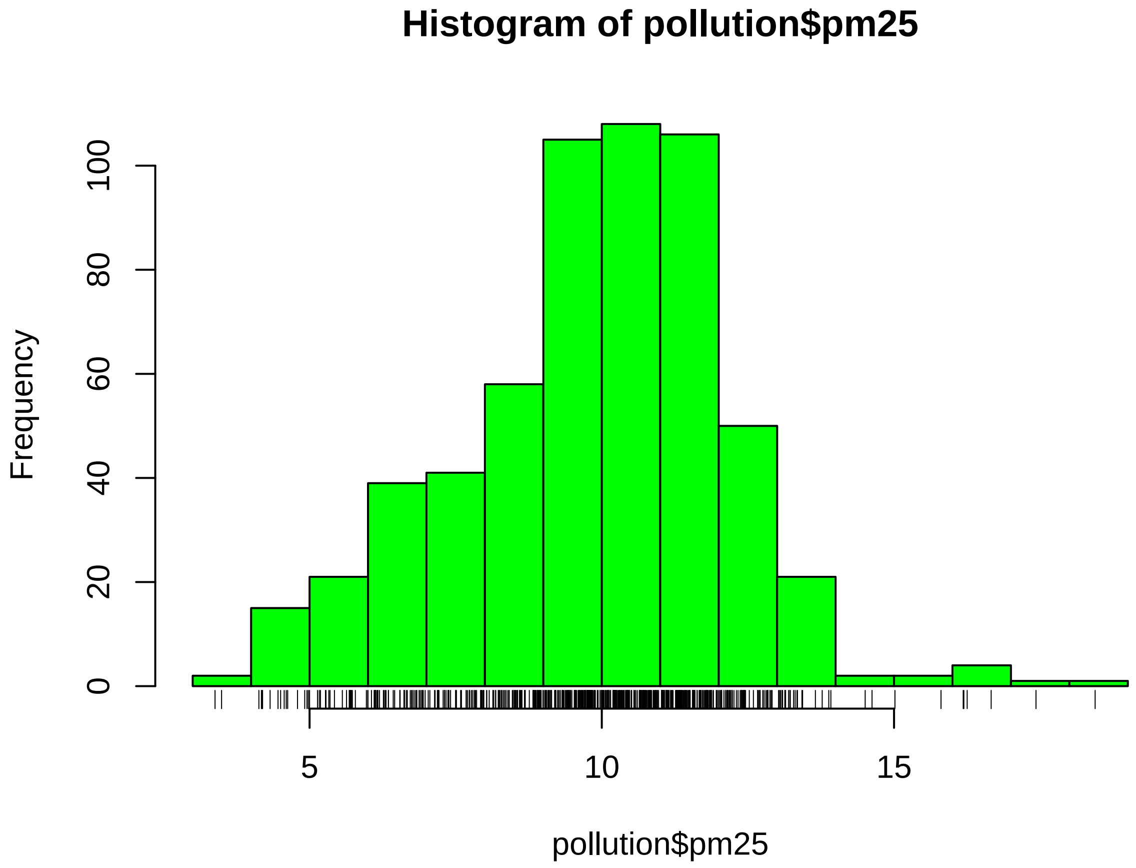
Histogram

```r
hist(pollution$pm25, col = "green")
```



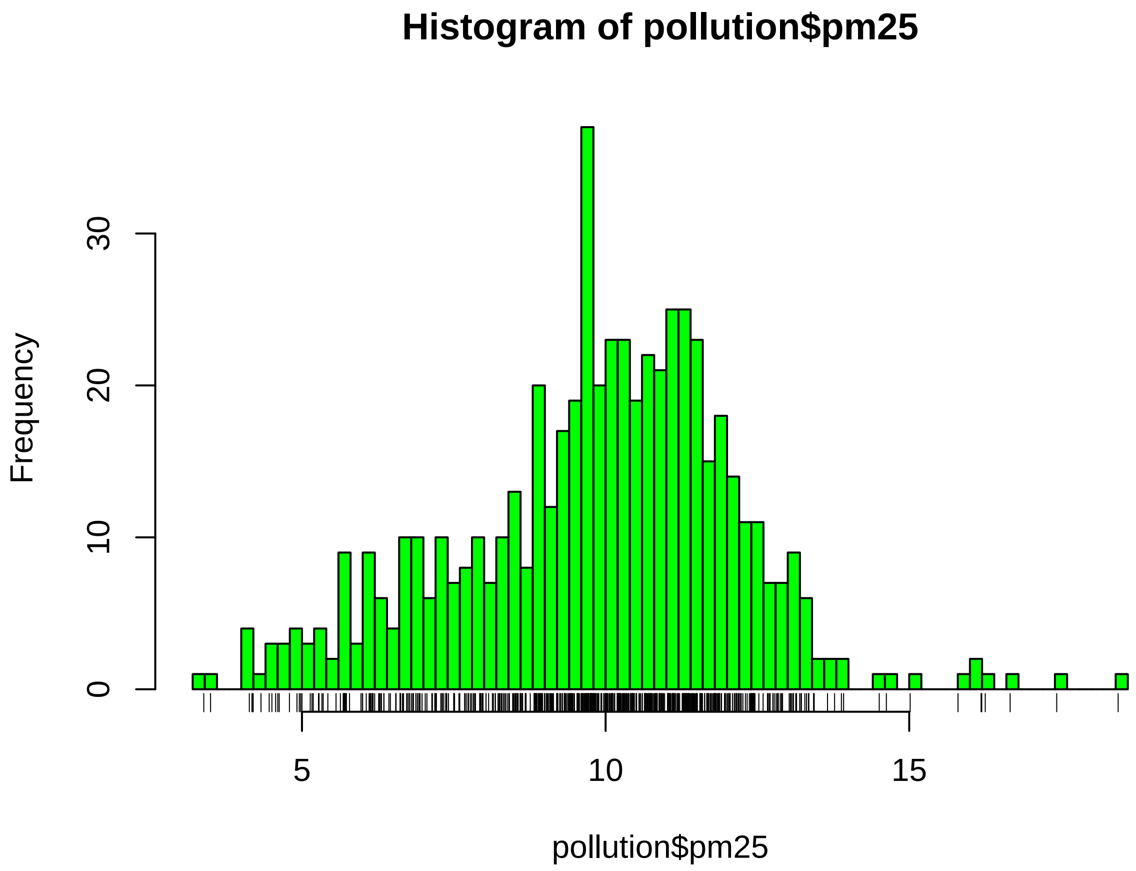
Histogram

```r
hist(pollution$pm25, col = "green")
rug(pollution$pm25)
```



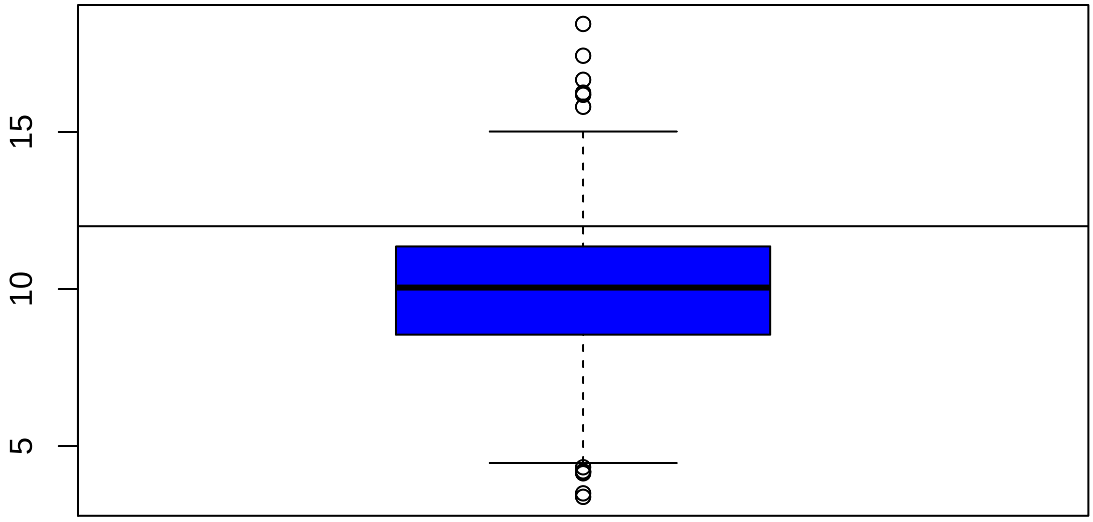
Histogram

```r
hist(pollution$pm25, col = "green", breaks = 100)
rug(pollution$pm25)
```



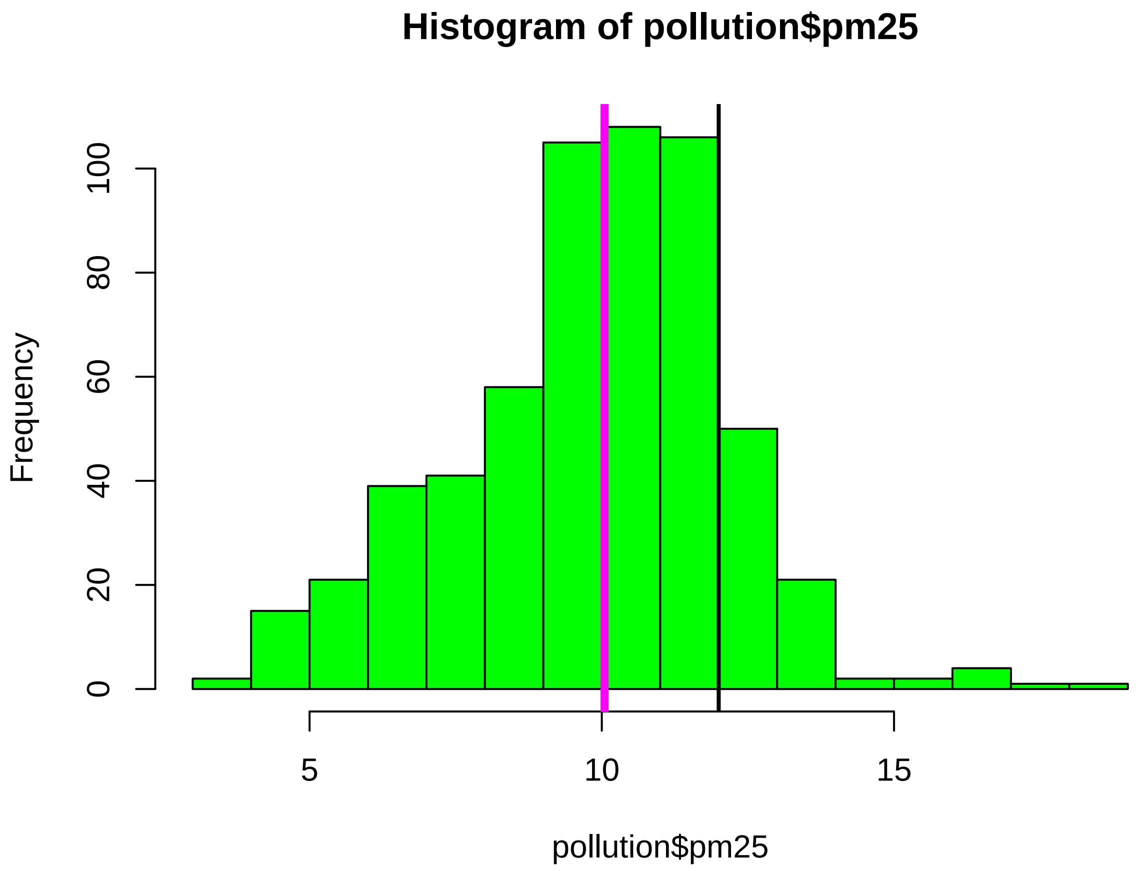
Overlaying Features

```
boxplot(pollution$pm25, col = "blue")
abline(h = 12)
```



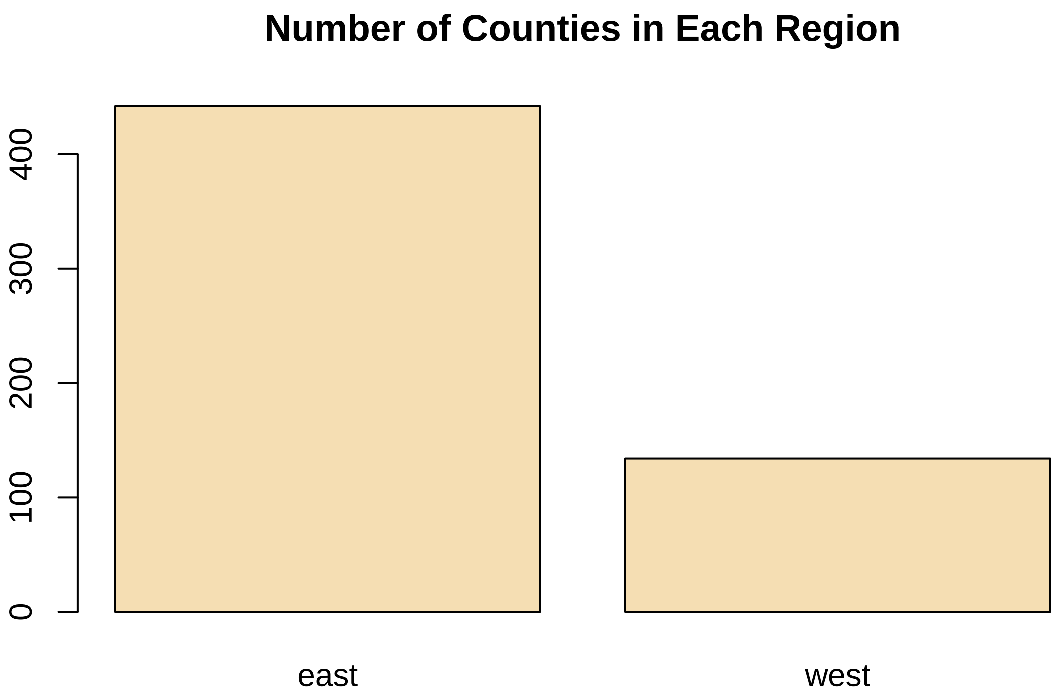
Overlaying Features

```
hist(pollution$pm25, col = "green")
abline(v = 12, lwd = 2)
abline(v = median(pollution$pm25), col = "magenta", lwd = 4)
```



Barplot

```
barplot(table(pollution$region), col = "wheat", main = "Number of Counties in Each Region")
```



Simple Summaries of Data

Two dimensions

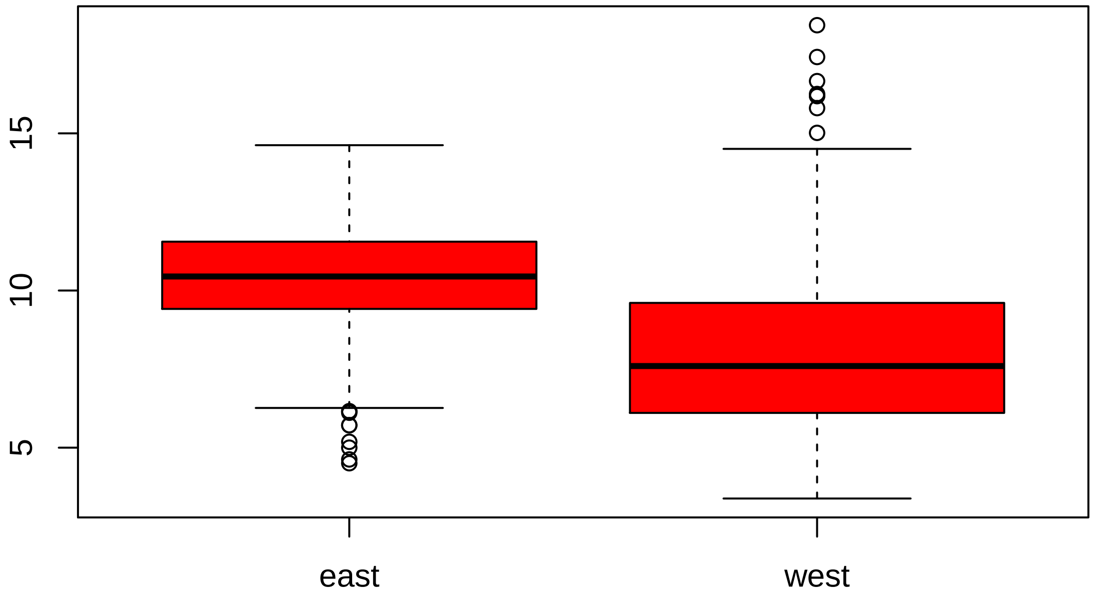
- Multiple/overlayed 1-D plots (Lattice/ggplot2)
- Scatterplots
- Smooth scatterplots

> 2 dimensions

- Overlayed/multiple 2-D plots; coplots
- Use color, size, shape to add dimensions
- Spinning plots
- Actual 3-D plots (not that useful)

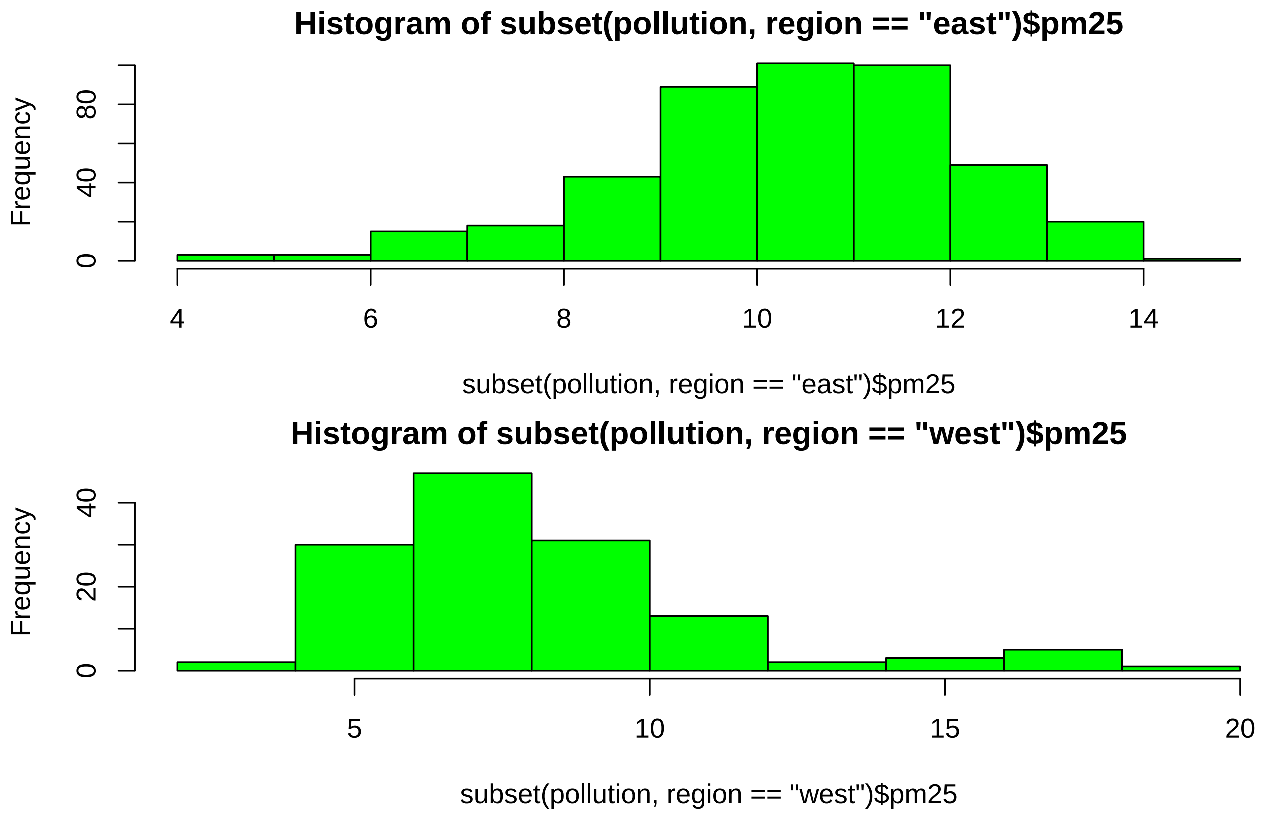
Multiple Boxplots

```r
boxplot(pm25 ~ region, data = pollution, col = "red")
```



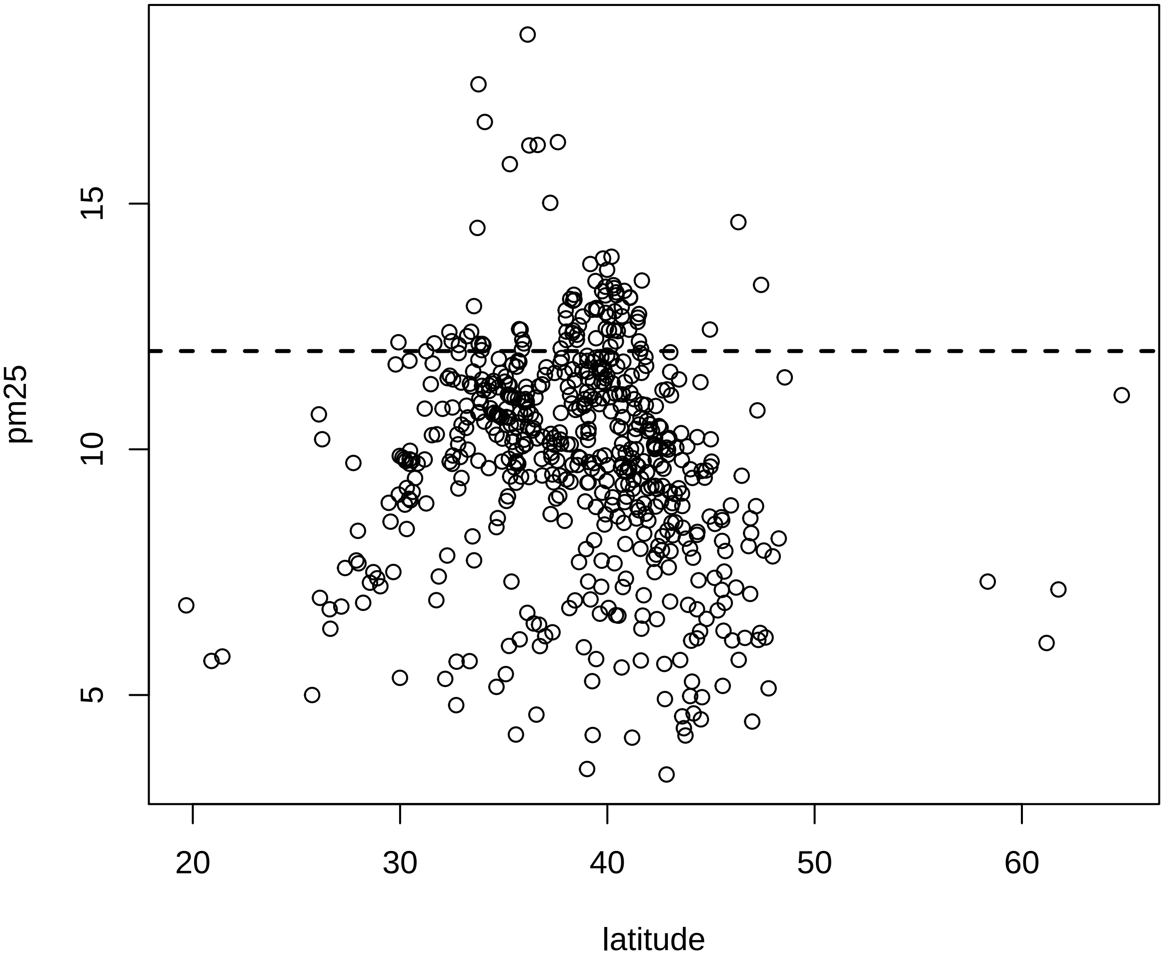
Multiple Histograms

```r
par(mfrow = c(2, 1), mar = c(4, 4, 2, 1))
hist(subset(pollution, region == "east")$pm25, col = "green")
hist(subset(pollution, region == "west")$pm25, col = "green")
```



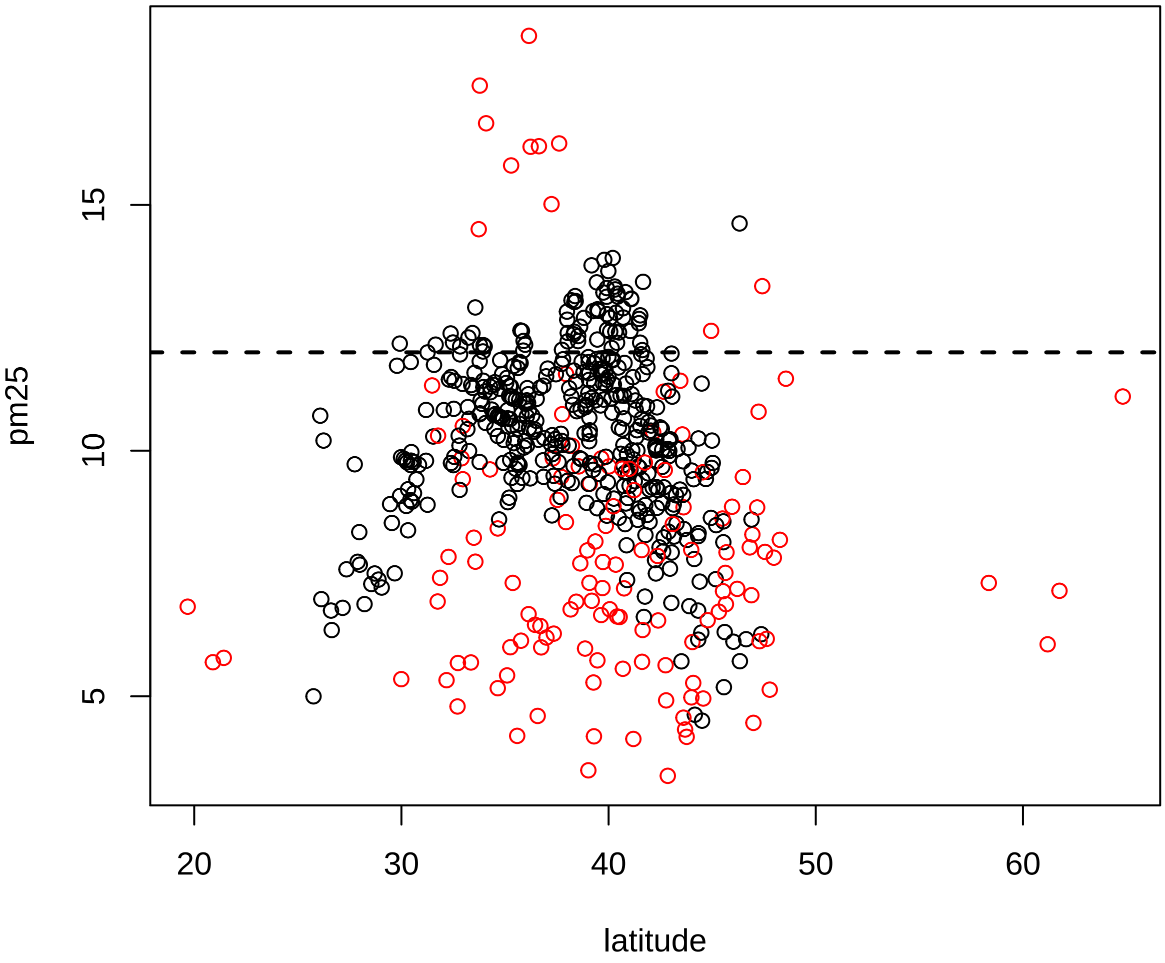
Scatterplot

```
with(pollution, plot(latitude, pm25))
abline(h = 12, lwd = 2, lty = 2)
```



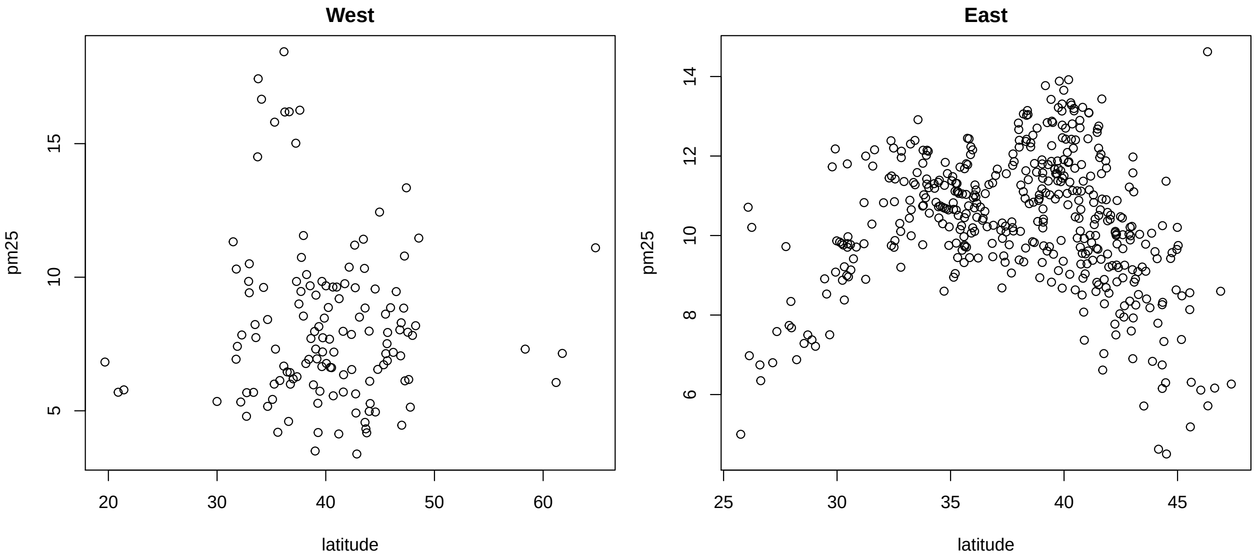
Scatterplot - Using Color

```
with(pollution, plot(latitude, pm25, col = region))
abline(h = 12, lwd = 2, lty = 2)
```



Multiple Scatterplots

```r
par(mfrow = c(1, 2), mar = c(5, 4, 2, 1))
with(subset(pollution, region == "west"), plot(latitude, pm25, main = "West"))
with(subset(pollution, region == "east"), plot(latitude, pm25, main = "East"))
```



Summary

- Exploratory plots are “quick and dirty”
- Let you summarize the data (usually graphically) and highlight any broad features
- Explore basic questions and hypotheses (and perhaps rule them out)
- Suggest modeling strategies for the “next step”

Further resources

- R Graph Gallery
- R Bloggers