Data Science
CS301

Exploratory First Steps, Continued

Week 4
Fall 2024
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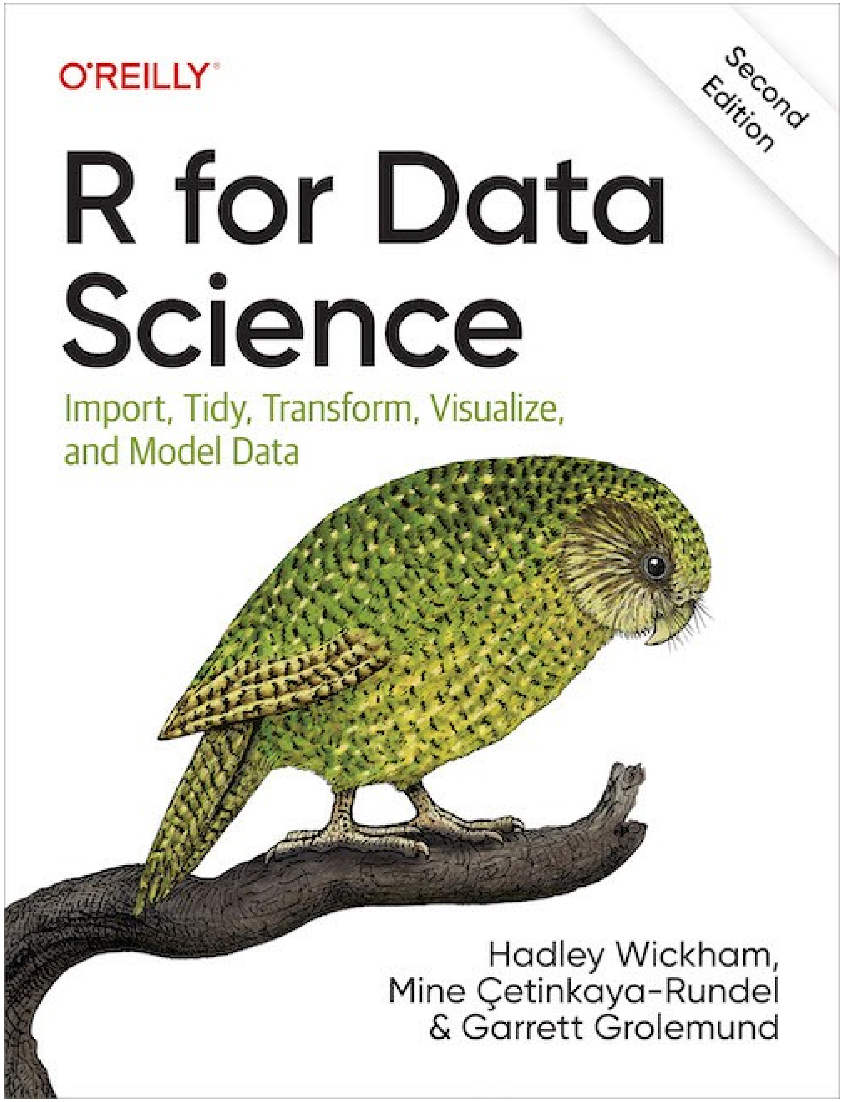
Where in the Web?



Web:

Chap 10: Exploratory Data Analysis

- https://r4ds.hadley.nz/eda

Missing Data Points?

Missing Data Entries

- Missing data in R appears as ***NA***.
- *NA* is not a string or a numeric value, but an indicator of missing data.
- Let's create vectors with missing values to test

```
library(tidyverse)
library(tibble)
x1 <- c(1, 4, 3, NA, 7)
x2 <- c("a", "B", NA, "NA")
is.na(x1)
is.na(x2)
```

Spot missing data

Missing Data Entries

- What to do when elements of your data go missing?
- **Why not just DROP the ENTIRE ROW, as well as to drop all the value contained by its other variables as well??**

```
diamonds2 <- diamonds  %>%  filter(between(y, 3, 20))
```

This is a shortcut for y >= 3 & y <= 20

```
View(diamonds2)

# compare to the the size of original dataset

View(diamonds)

# Note: Good data may have been lost by dropping rows.
```

IfElse(): Condition Statement

```
y = ifelse(y < 3 | y > 20, NA, y)
```

- **Function**
- **Test Condition**
- **If True, then assign this**
- **If False, then assign this**

Data: *Diamond*

\# The book recommends to *mark* the data as bad or missing.

diamonds2 <- diamonds %>%

mutate(y = **ifelse(y < 3 | y > 20, NA, y)**)

\# syntax: `ifelse(test, yes, no)`

\# Inspect each value of *y*. If the *y* is not between 3 and 20, then *y* = NA, else *y* = *y*

We Plot All Non-NA Values

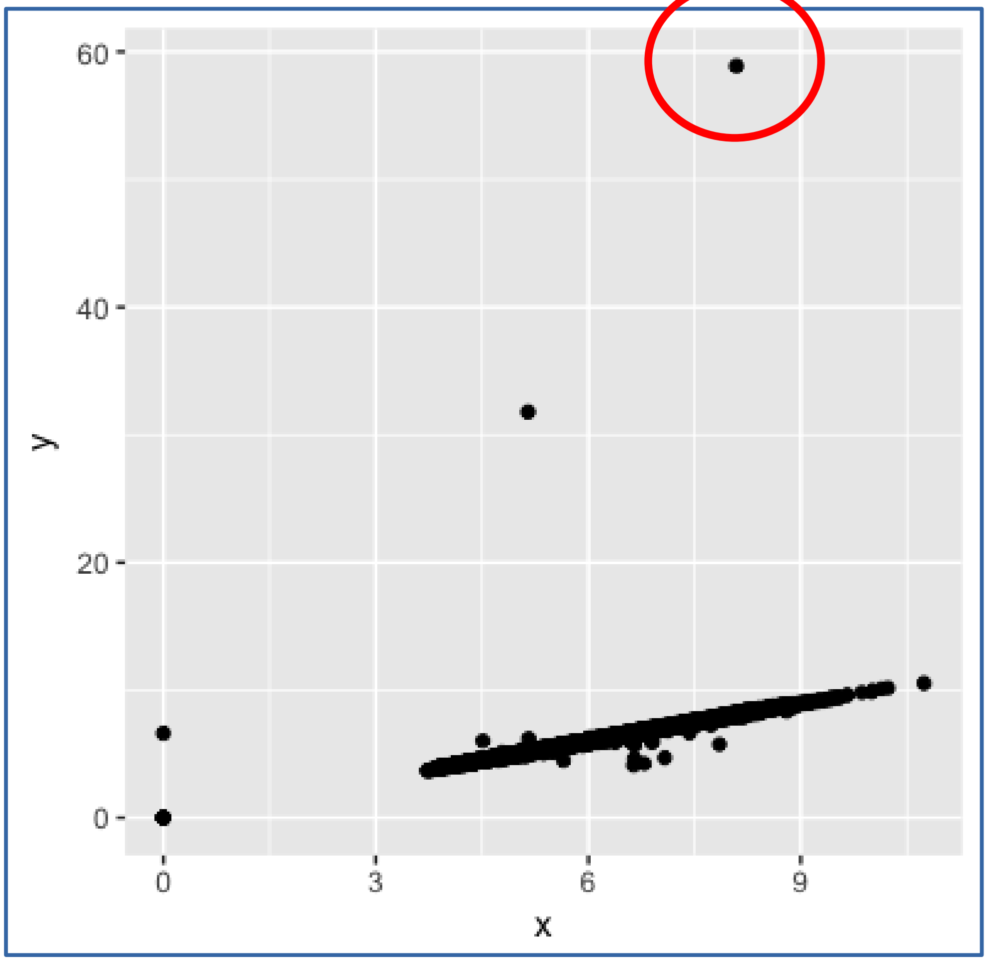
```
# Missing, outliers values marked as NA

ggplot(data = diamonds2, mapping = aes(x = x, y = y)) +  geom_point()

# compared to, no removed missing or outlier values

ggplot(data = diamonds, mapping = aes(x = x, y = y)) +  geom_point()
```

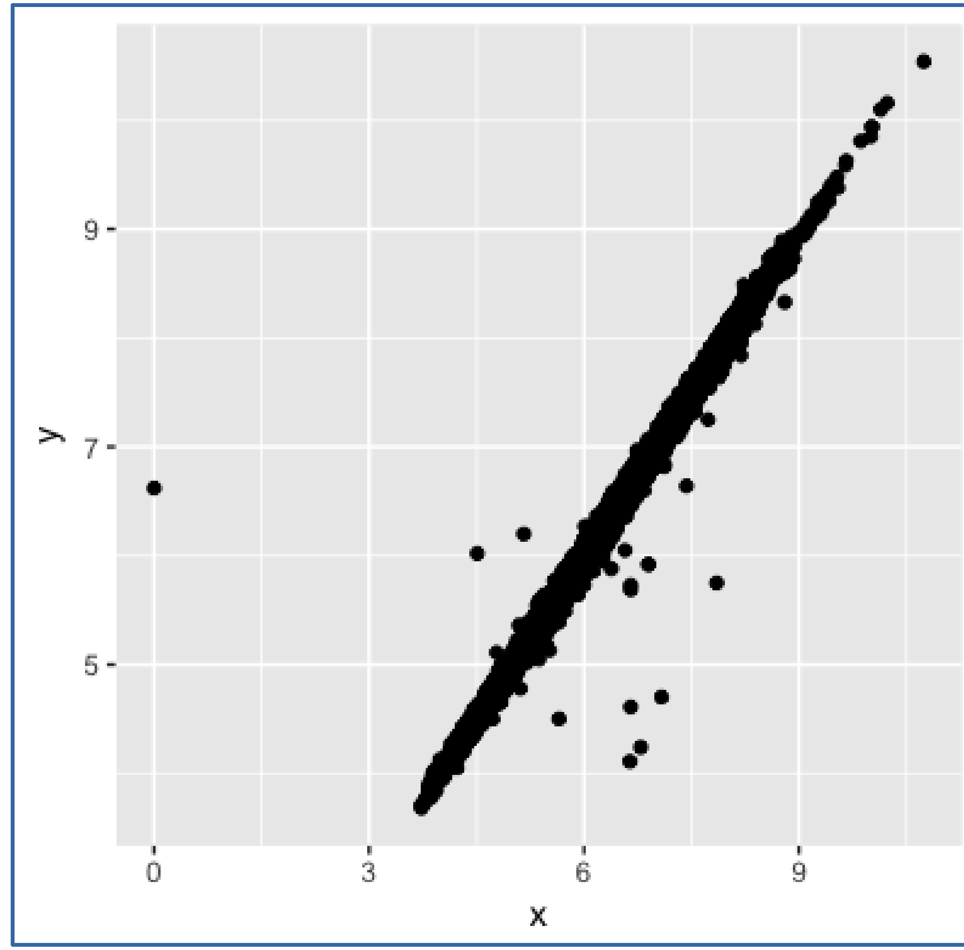
Missing Values, continued

```
# remove the outliers for y (I.e., y<3 and y >20)

library(tidyverse)

diamonds2 <- diamonds %>%  mutate(y = ifelse(y < 3 | y > 20, NA, y))

ggplot(data = diamonds2, mapping = aes(x = x, y = y)) +  geom_point()
```

Add the ifelse() code directly to your other code.

Trimmed Data, Slightly Different Plot...





- Left: WITH outliers
- Above: NO outliers

Data: *Diamond*

Can you use the below code to further trim outliers or missing data?

Plot your new graphic after using *ifelse()*

```
diamonds3 <- diamonds %>%
  mutate(y = ifelse(y < ## | y > ##, NA, y))
```

Missing Values May Have Their Own Meanings

- Does missing flight arrival-time data indicate canceled flights?

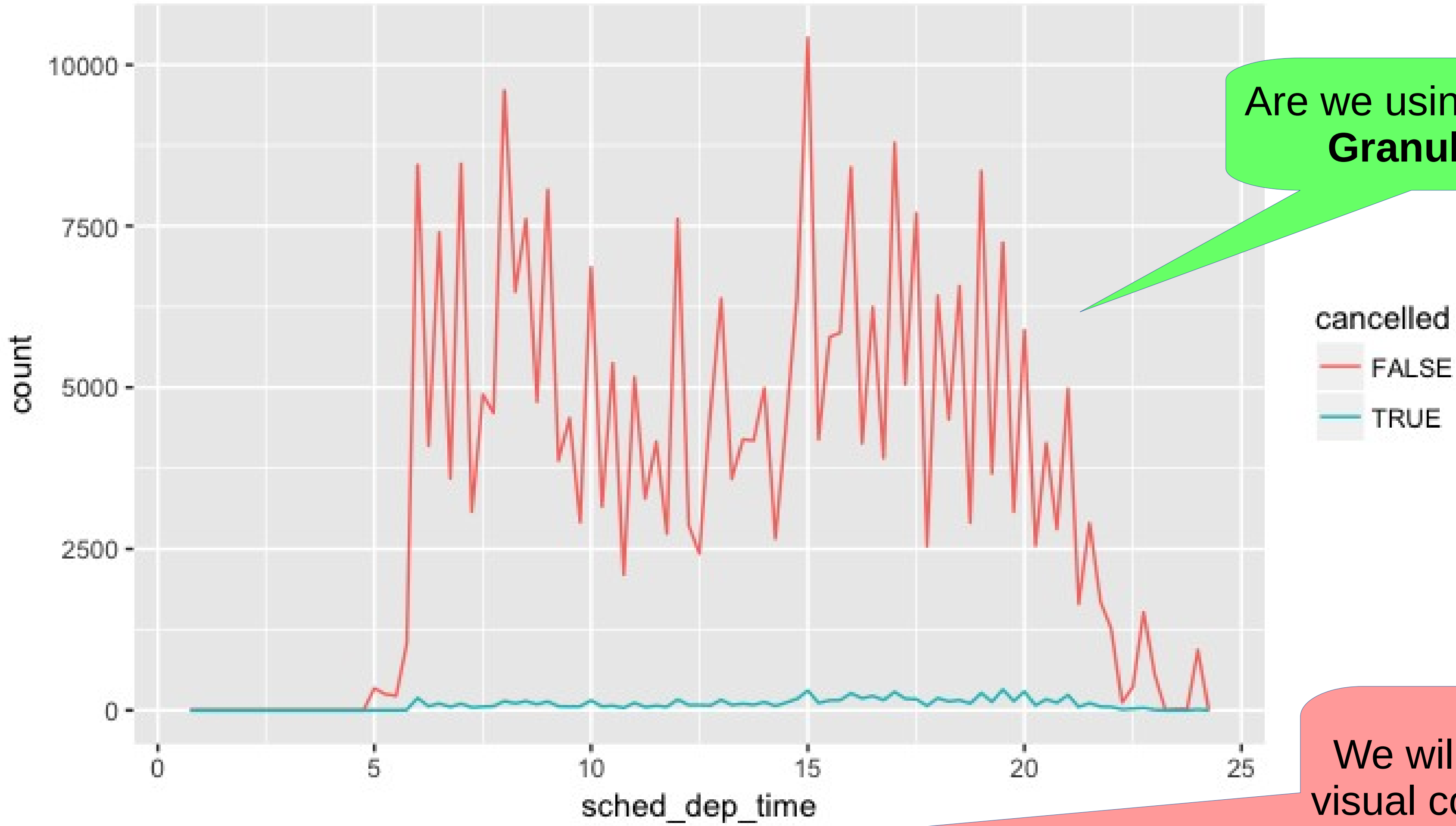
Missing Values May Have Their Own Meanings

```
# install the flights data, if necessary.
install.packages("nycflights13")
library(tidyverse, nycflights13)
flights <- nycflights13::flights
View(flights)
# Where are the missing values
flights$dep_time
```

The Distribution of a C**ontinuous** Variable, Aggregated By a C**ategorical** variable

```
# compare the scheduled departure times for cancelled and non-cancelled times

flights %>%

  mutate(

    cancelled = is.na(dep_time),

    sched_hour = sched_dep_time %/% 100,

    sched_min = sched_dep_time %% 100,

    sched_dep_time = sched_hour + sched_min / 60

  ) %>%

  ggplot(mapping = aes(sched_dep_time)) +

  geom_freqpoly(mapping = aes(colour = cancelled),

  binwidth = 1/4)
```

Potential Pitfalls in Theory



Are we using the best **Granularity**?

We will return to visual comparisons

- We get an slight idea of when cancellations happen
- Many more non-cancelled flights than cancelled flights: *does the business side of flying introduce a bias for not-canceling flights?*

Covariation

covariance

co·var·i·ance

/ˌkōˈverēəns/

noun

1. MATHEMATICS
   the property of a function of retaining its form when the variables are linearly transformed.
2. STATISTICS
   the mean value of the product of the deviations of two variates from their respective means.

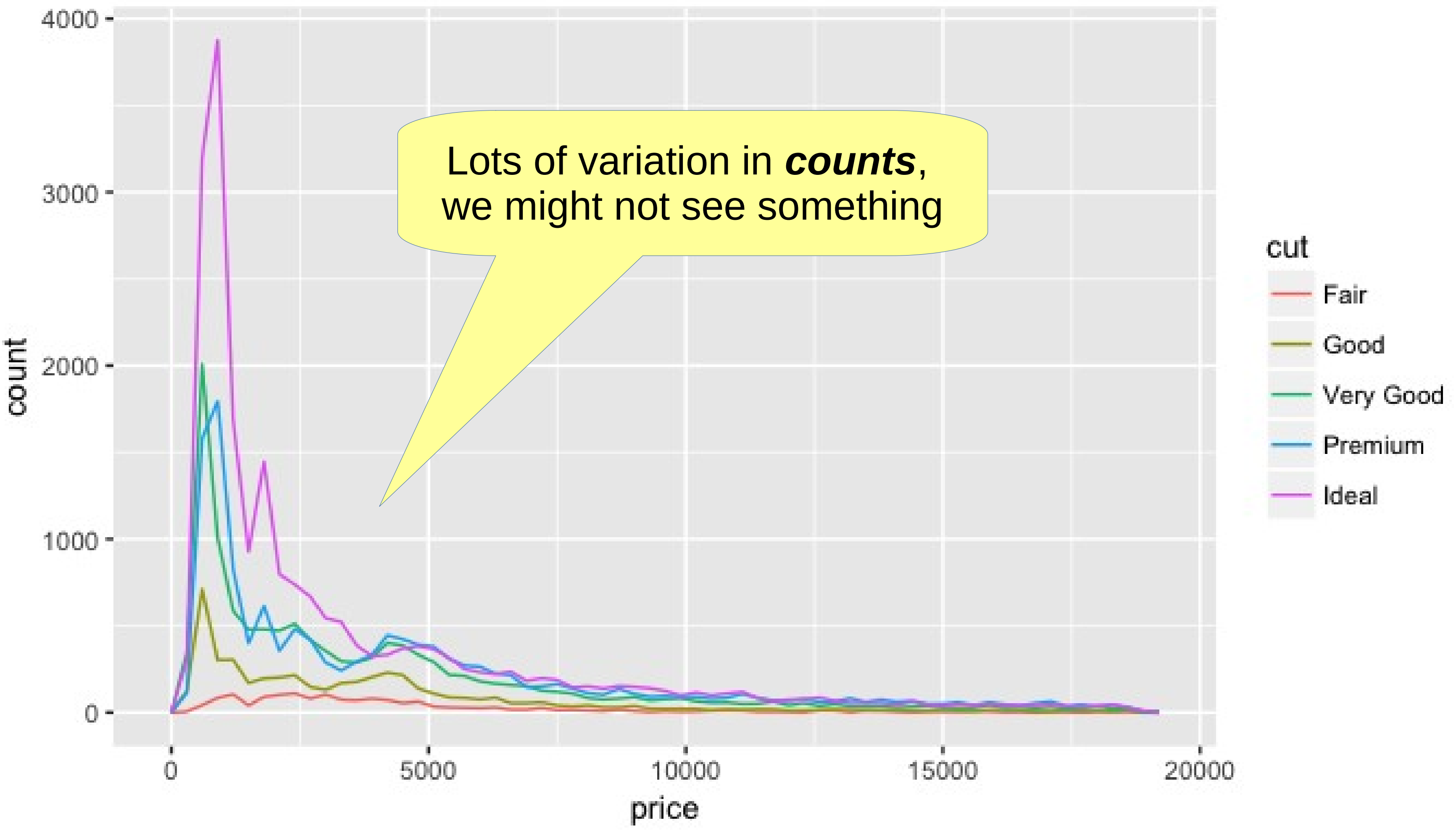
- **Covariation** is the tendency for the values of two or more variables to vary together in a related way.
- Study covariation by visualizing relationships between two or more variables.
- Pay attention to your variables to known how best to visualize these variables

Covariation

- How do the prices of diamonds vary with quality?

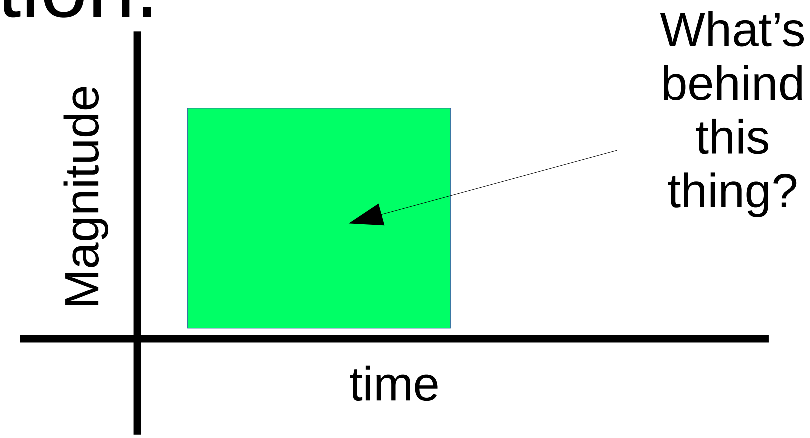
```
# Plot the count of each each cut quality according to price.

ggplot(data = diamonds, mapping = aes(x = price)) + geom_freqpoly(mapping = aes(colour = cut), binwidth = 500)
```

The Plot of the Diamond Counts



This Plot May Make It Hard To See The Phenomenon

- The counts variable seems to have values from all over the range.
- This is noise in our plot
- If one group is much smaller than the others, then it is hard to see the differences in its distribution.



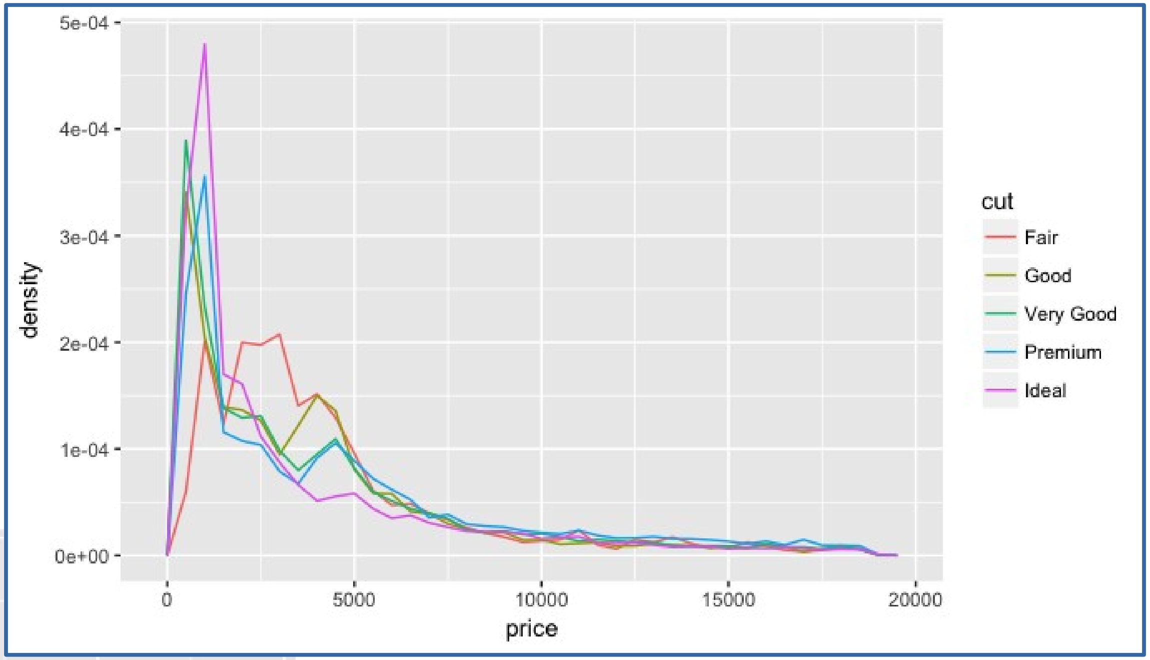
Let’s Change Our Plotting

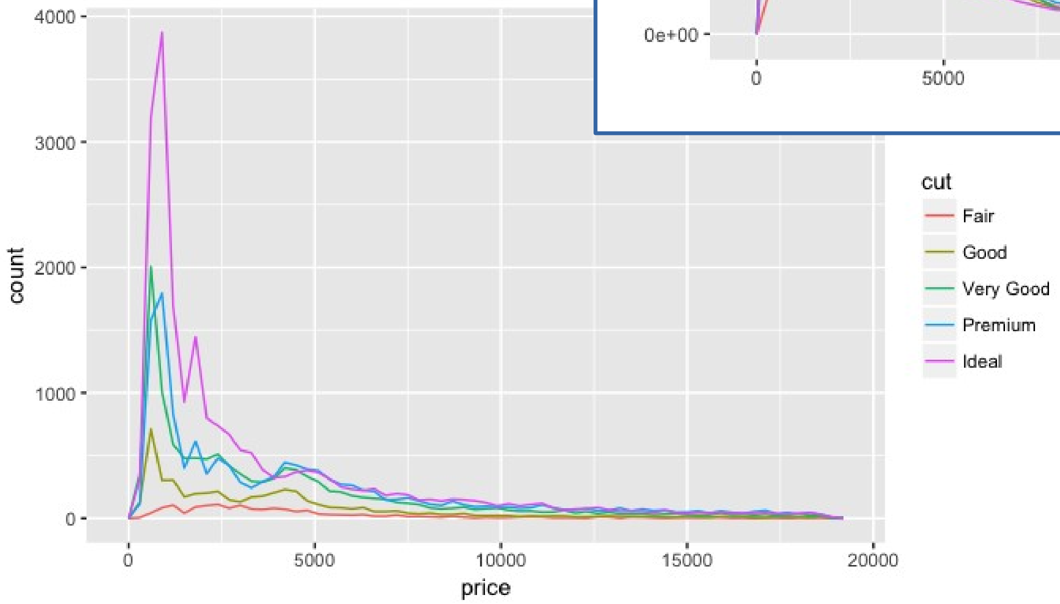
```
# Does a histogram help?
ggplot(diamonds) +  geom_bar(mapping = aes(x = cut))


#Note:  Density, is the count standardised so that the area under each frequency polygon is one.
# change the axis to see behind them.
ggplot(data = diamonds, mapping = aes(x = price, y = ..density..)) +  geom_freqpoly(mapping = aes(colour = cut), binwidth = 500)
```

Normalize Your View!

Different Plots

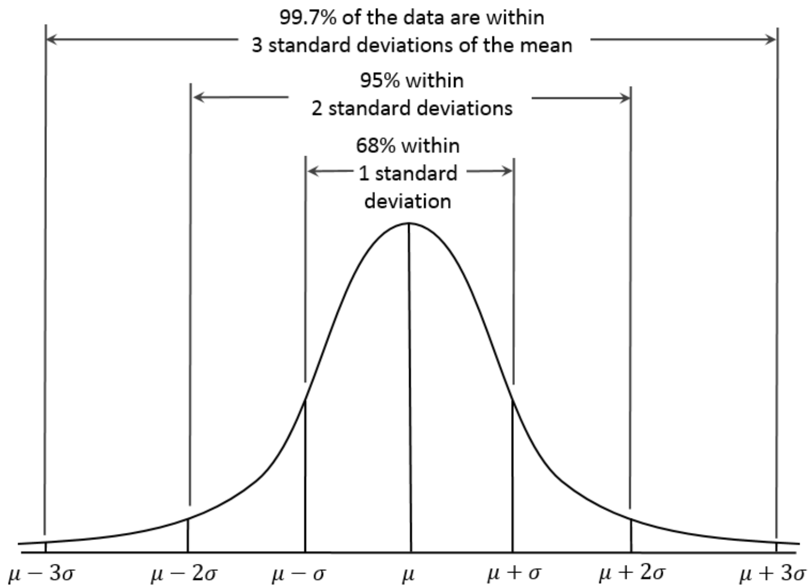
mapping = aes(
  x = price,
  y = **..density..**
)

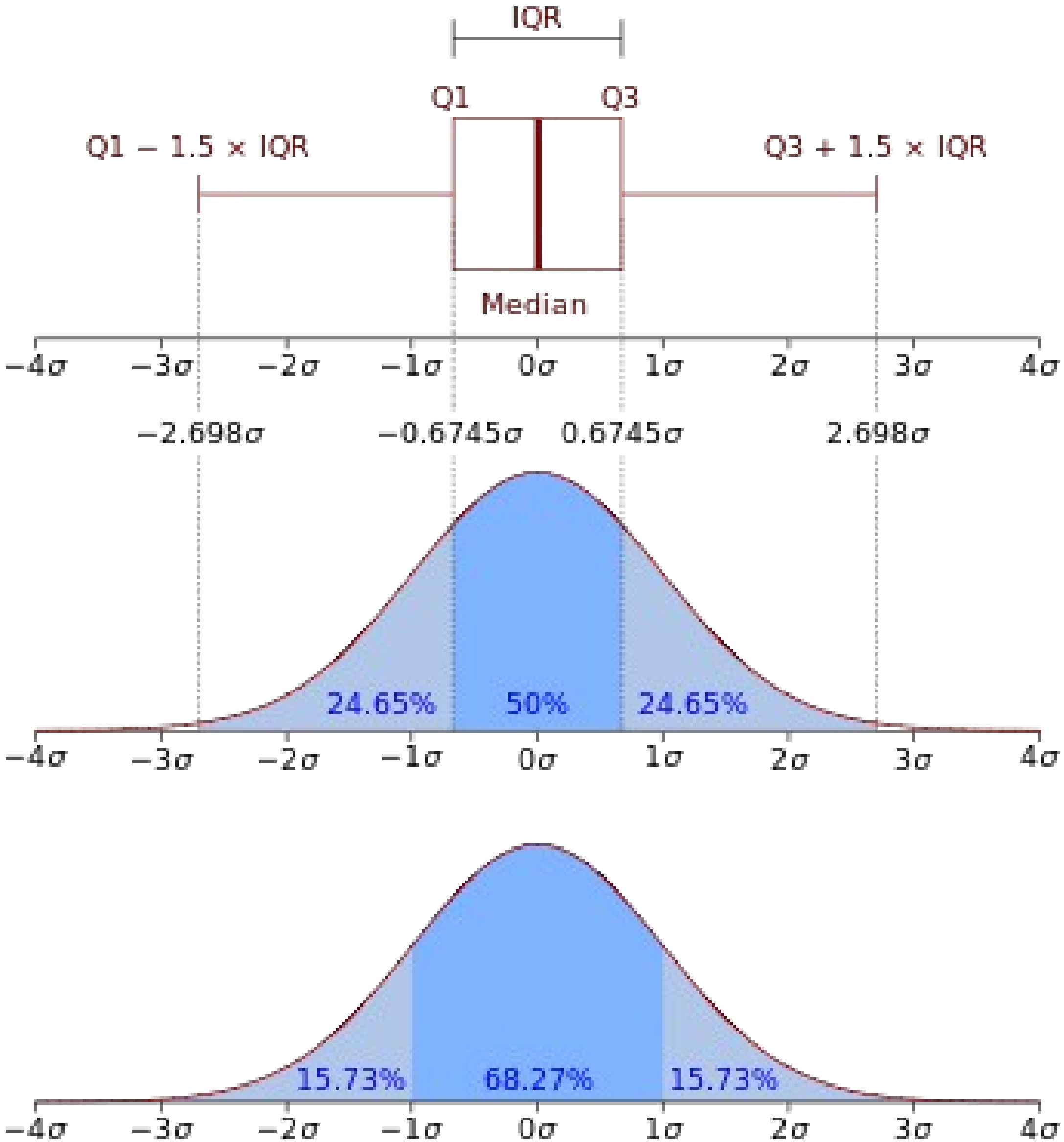




mapping = aes(
  x = price,
)

Box Plots

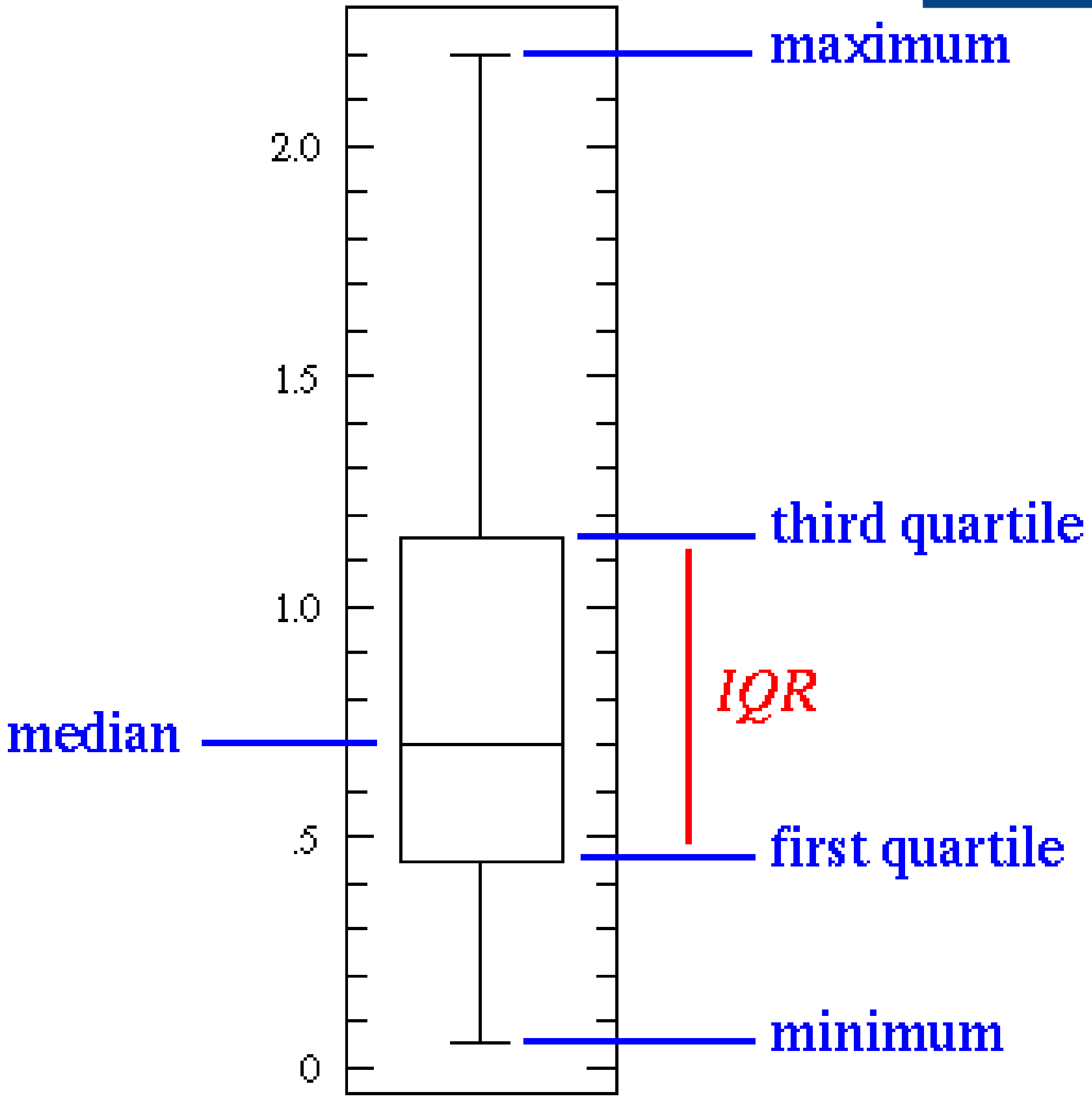




- For the normal distribution, the values less than one standard deviation away from the mean account for 68.27% of the set; while two standard deviations from the mean account for 95.45%; and three standard deviations account for 99.73%.

Explore Data Using Box Plots

Standardized way of displaying the distribution of data based on the five number summary: minimum, first quartile, median, third quartile, and maximum

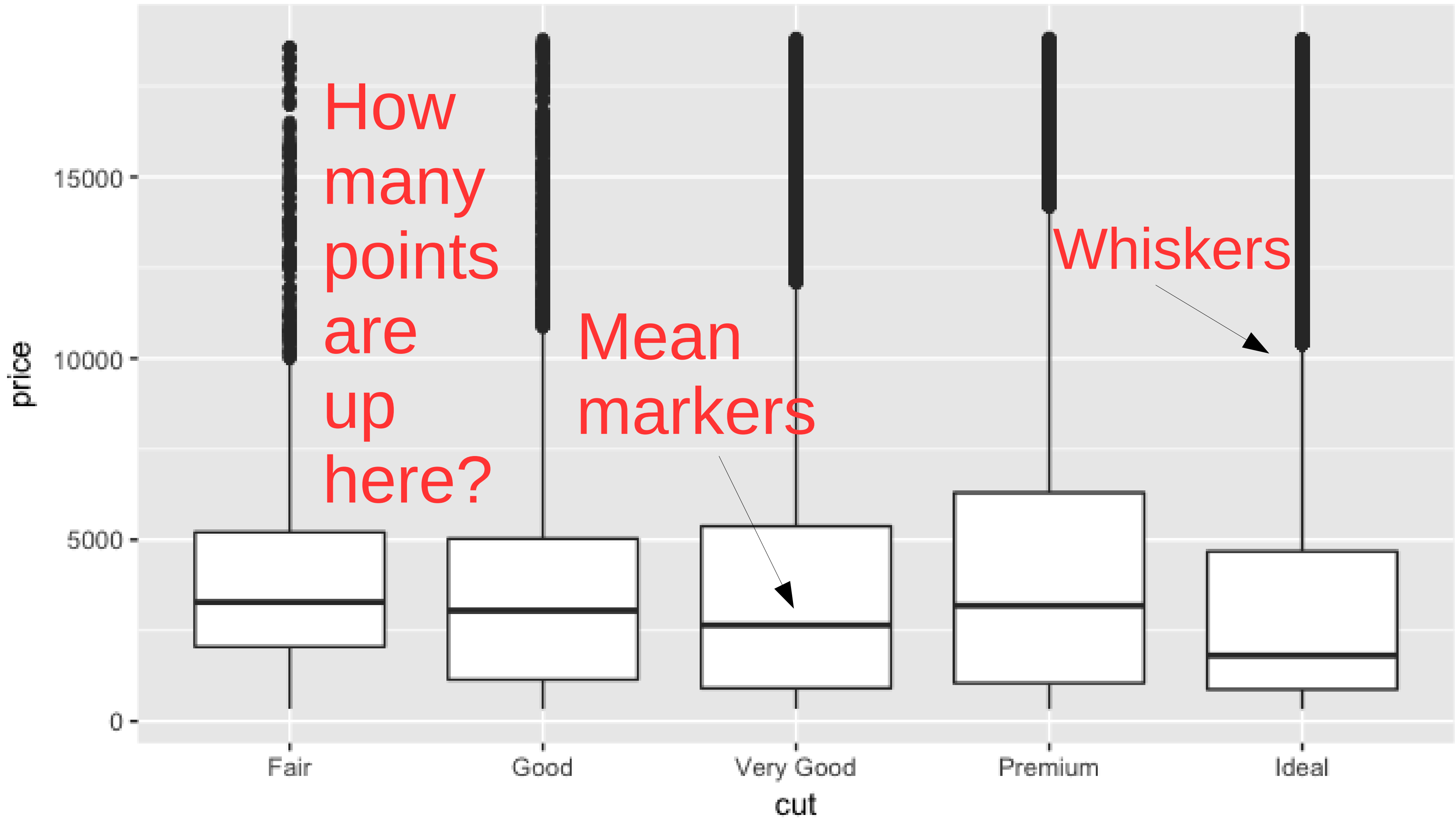


Explore Data Using Box Plots

Make a box plot to describe covariance between cut and price.

```
ggplot(data = diamonds, mapping = aes(x = cut, y = price)) + geom_boxplot()
```

Explore Data Using Box Plots



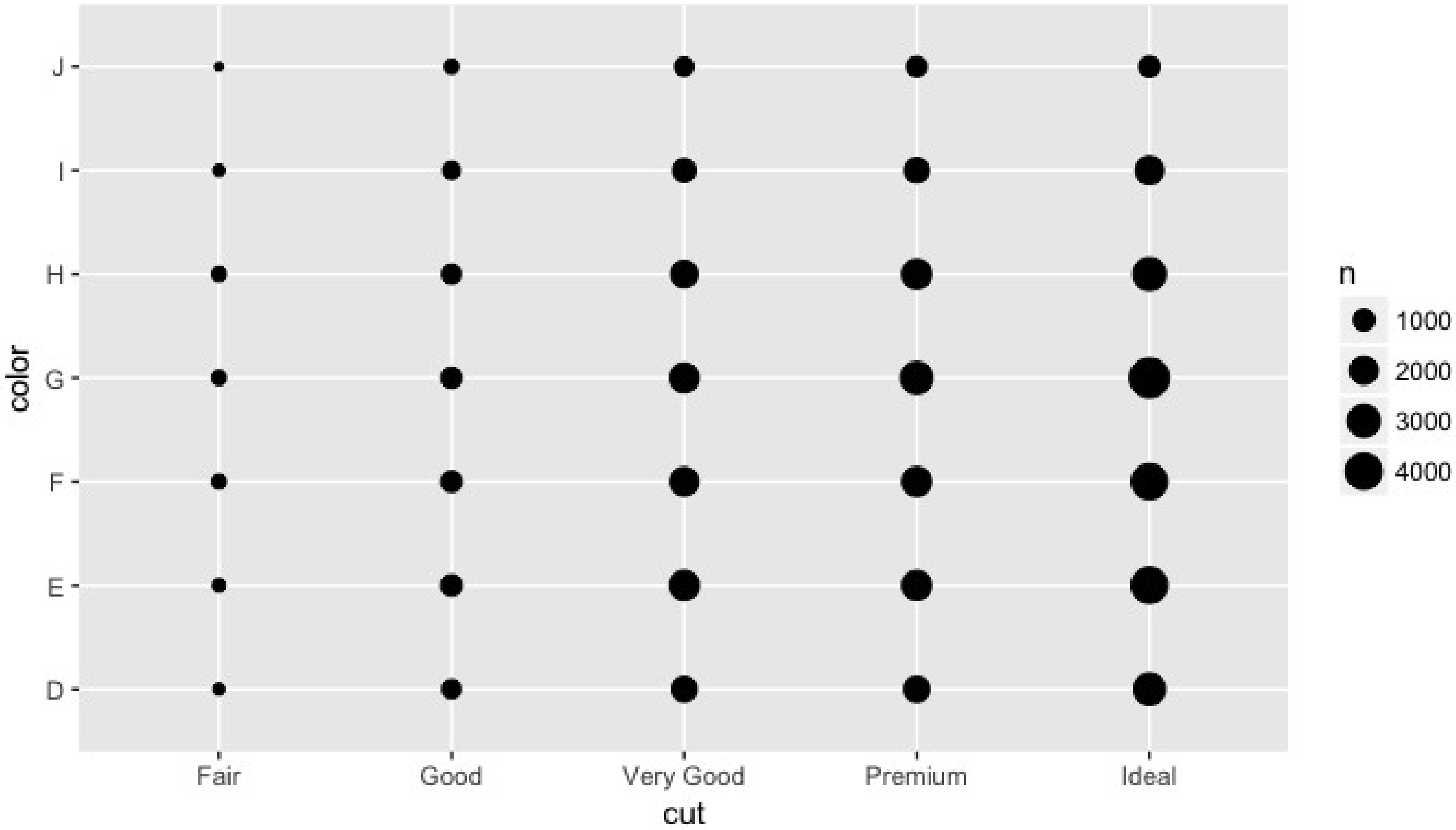
Box Plots: Pros and Cons

- Much less information about the *cut* distribution.
- Boxplots much more compact for convenient comparison
- Be careful, we could incorrectly conclude that better quality diamonds are cheaper on average.

Two Categorical Variables

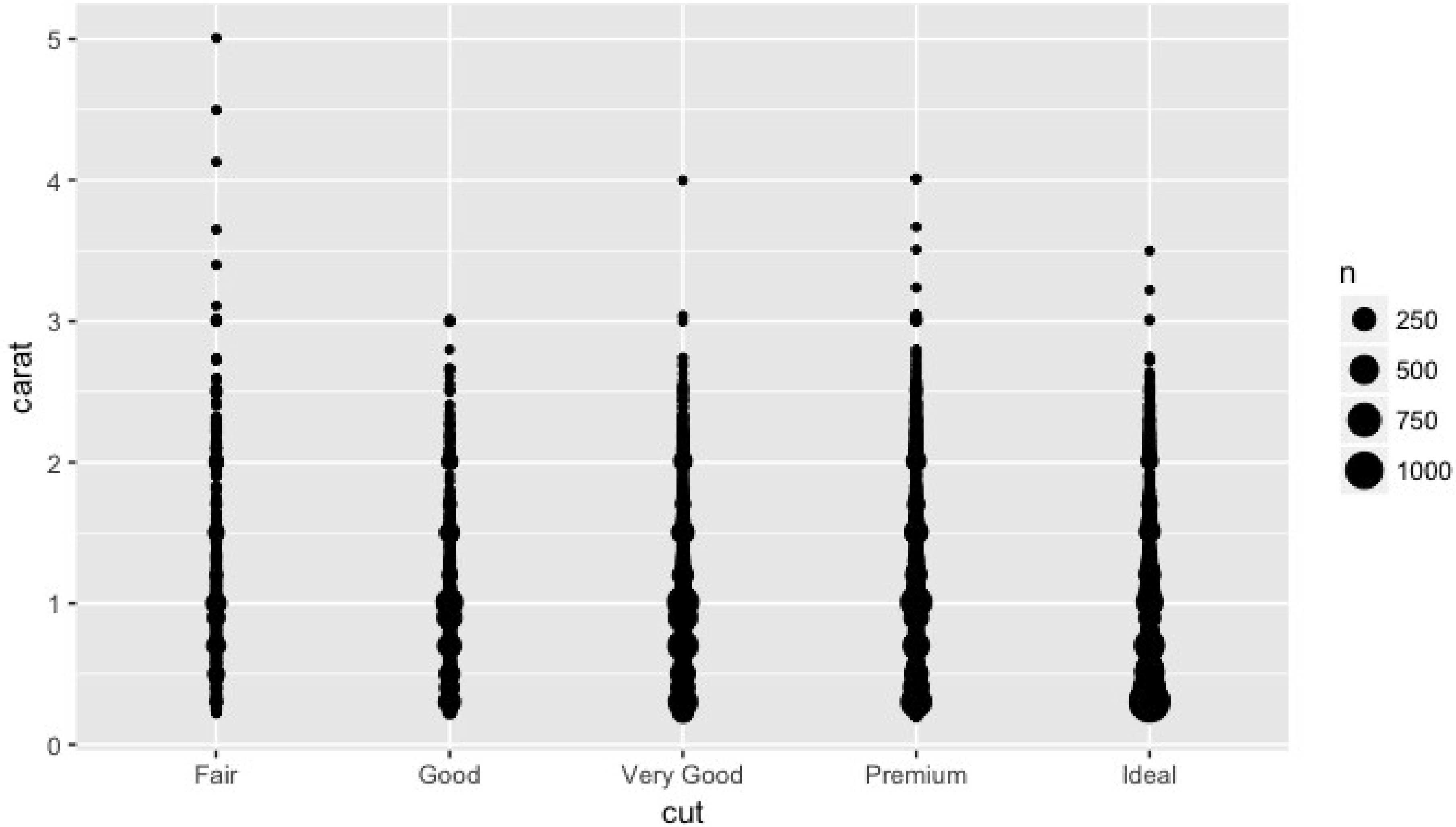
```
# Visualize the covariation between categorical variables with a "Plot of Dots" to determine observations.

ggplot(data = diamonds) +
geom_count(mapping = aes(x = cut, y = color))

# Note:  The size of each circle in the plot displays how many observations occurred at each combination of values

# Get exact text details of the plot

diamonds %>% count(color, cut)
```

Mini Distributions: Cut vs Color



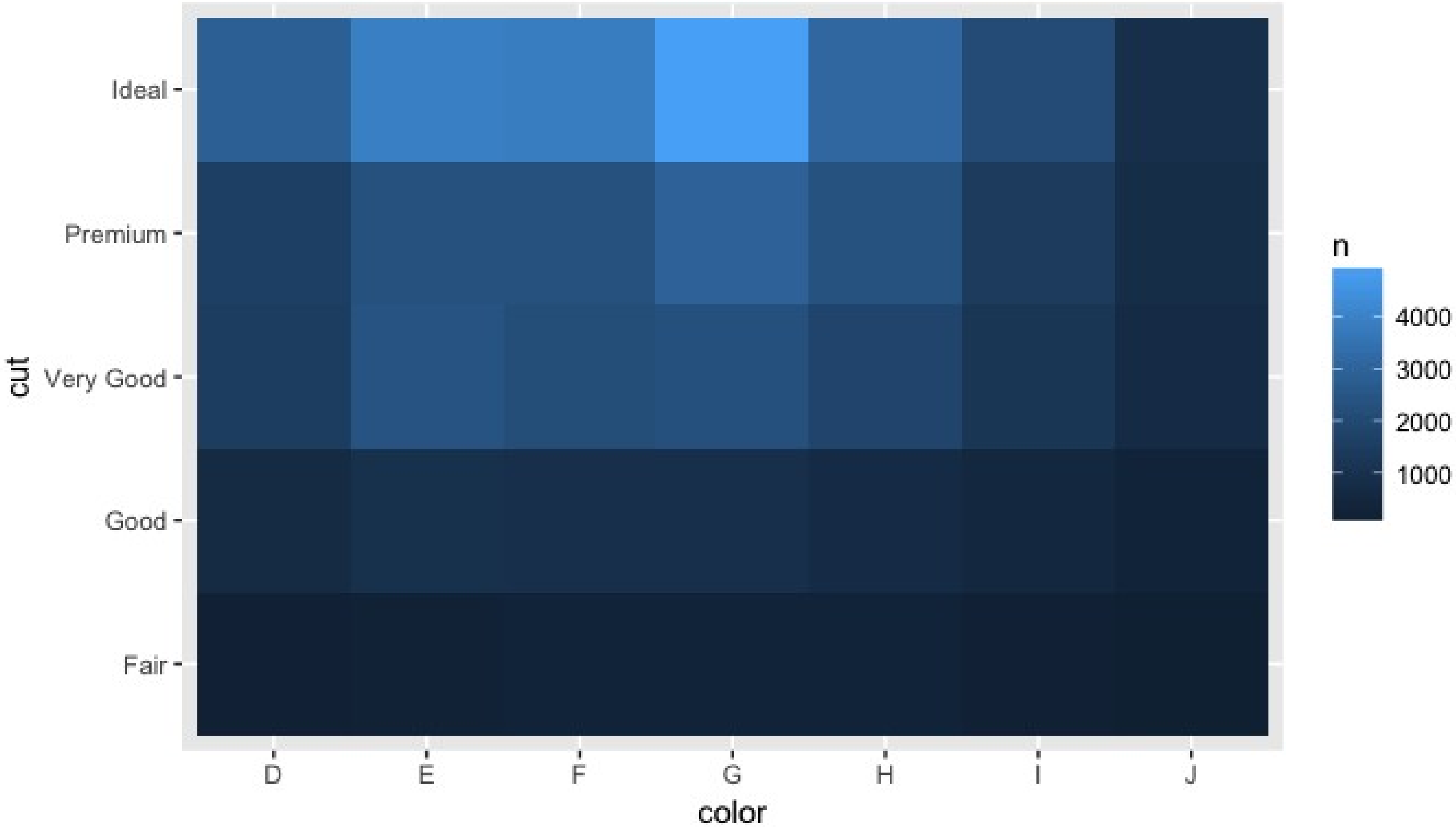

```
ggplot(data = diamonds) +
    geom_count(mapping = aes(x = cut, y = color))
```

Mini Distributions: Cut vs Carat



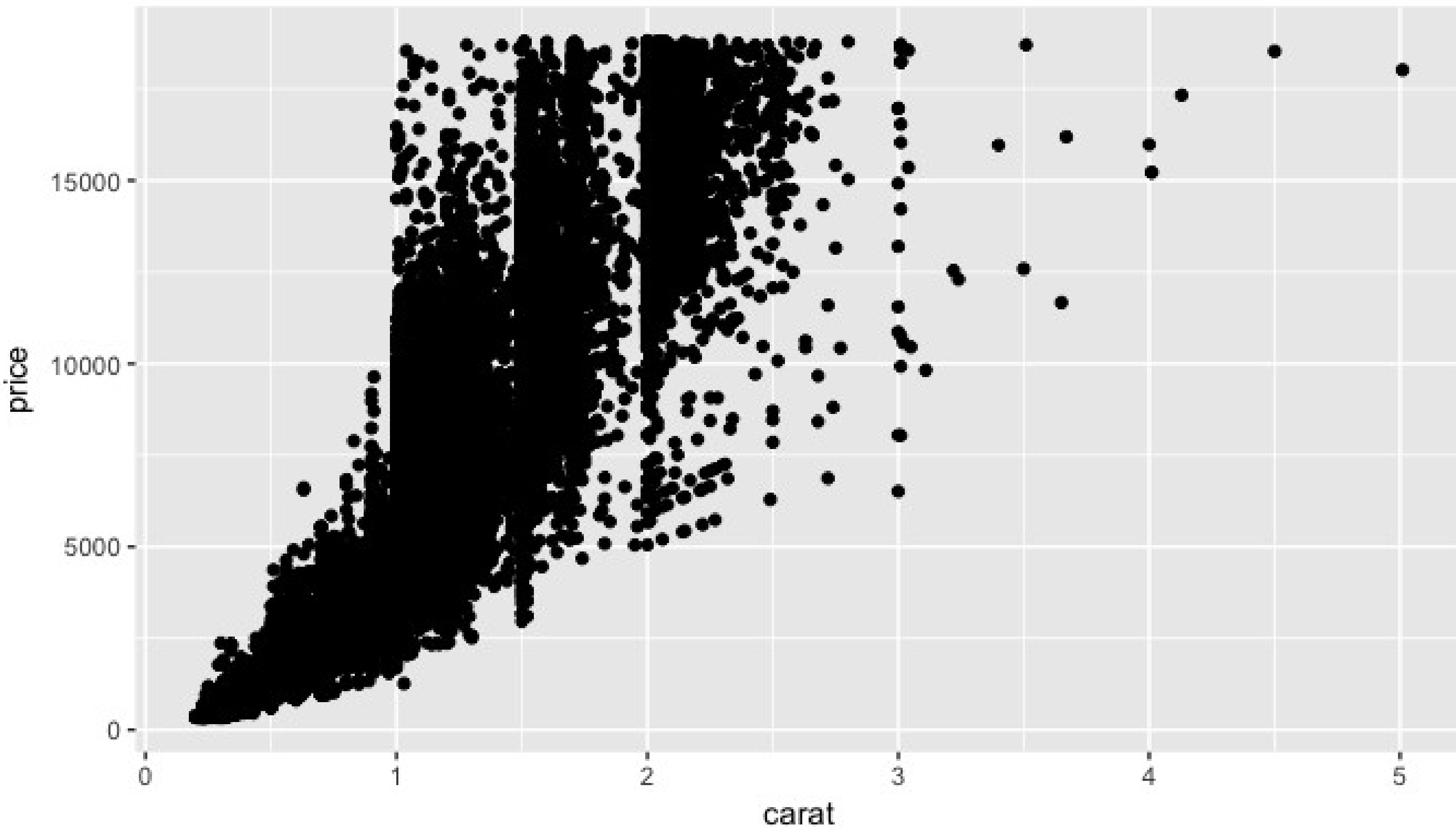
ggplot(data = diamonds) + geom_count(mapping = aes(x = cut, y = carat))

Mini Distributions: Cut vs Color



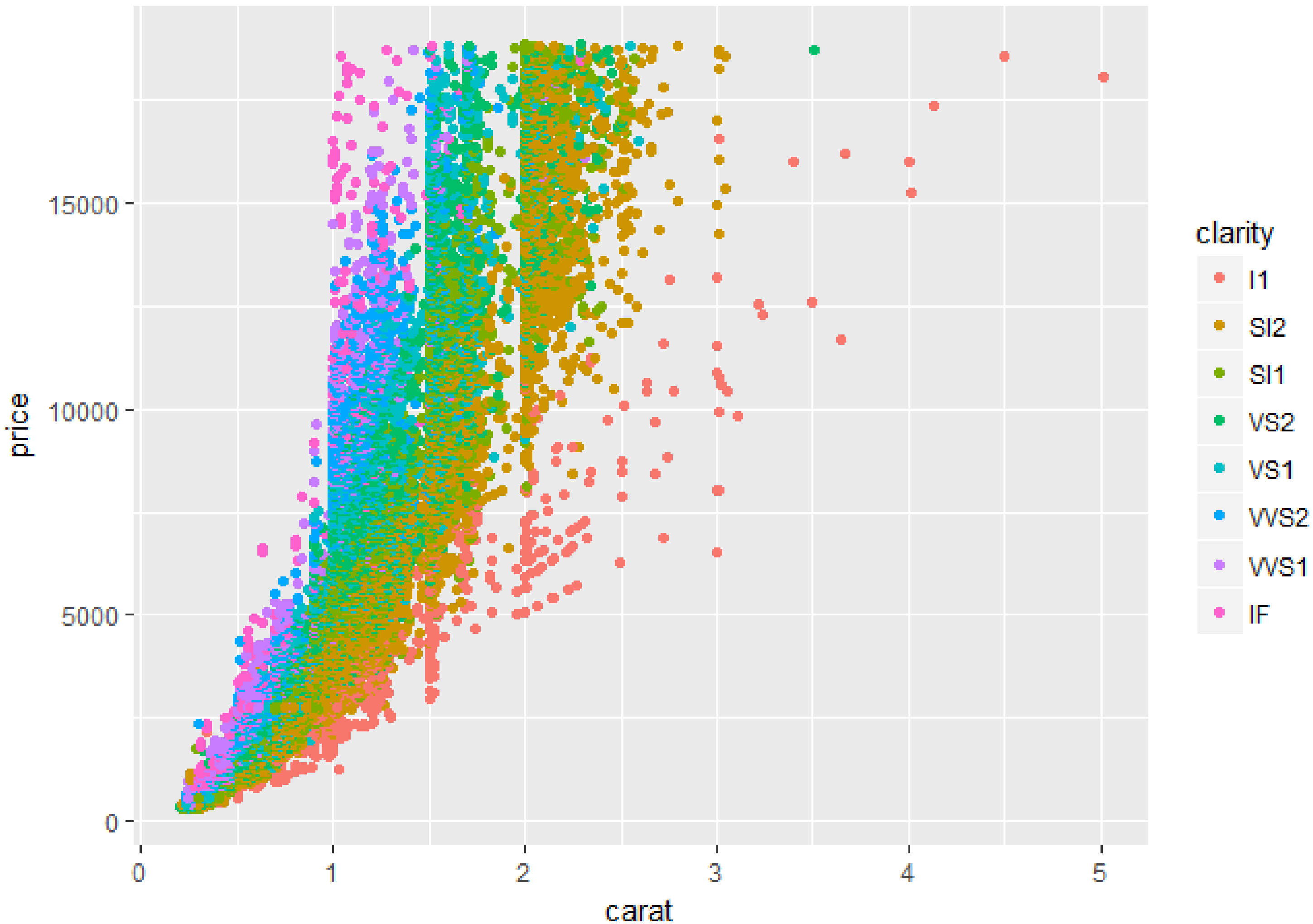

```
diamonds %>%
  count(color, cut) %>%
  ggplot(mapping = aes(x = color, y = cut)) +
    geom_tile(mapping = aes(fill = n))
```

Mini Distributions: Carat vs Price



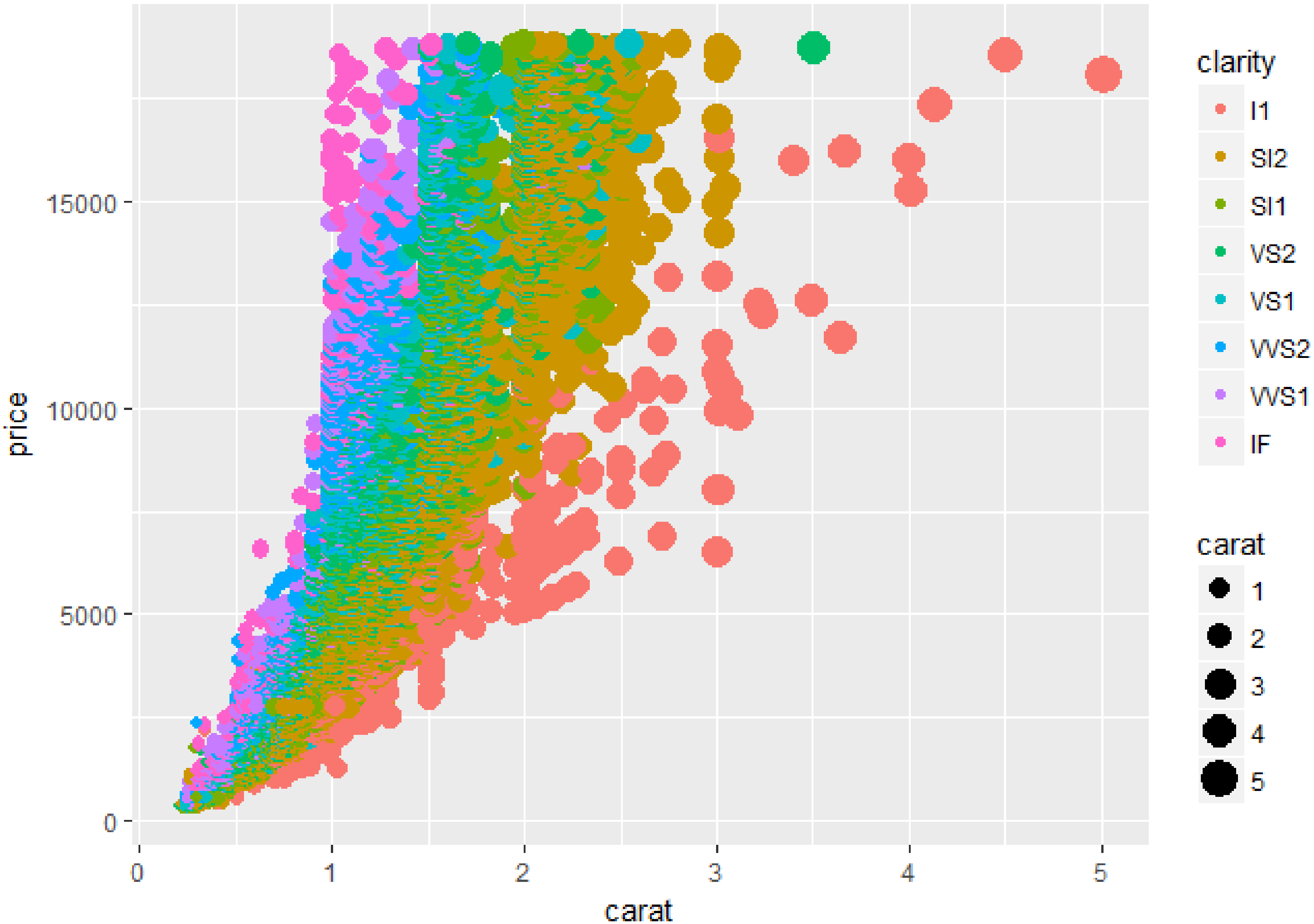

```
ggplot(data = diamonds) +
  geom_point(mapping = aes(x = carat, y = price))
```

Mini Distributions: Carat vs Price



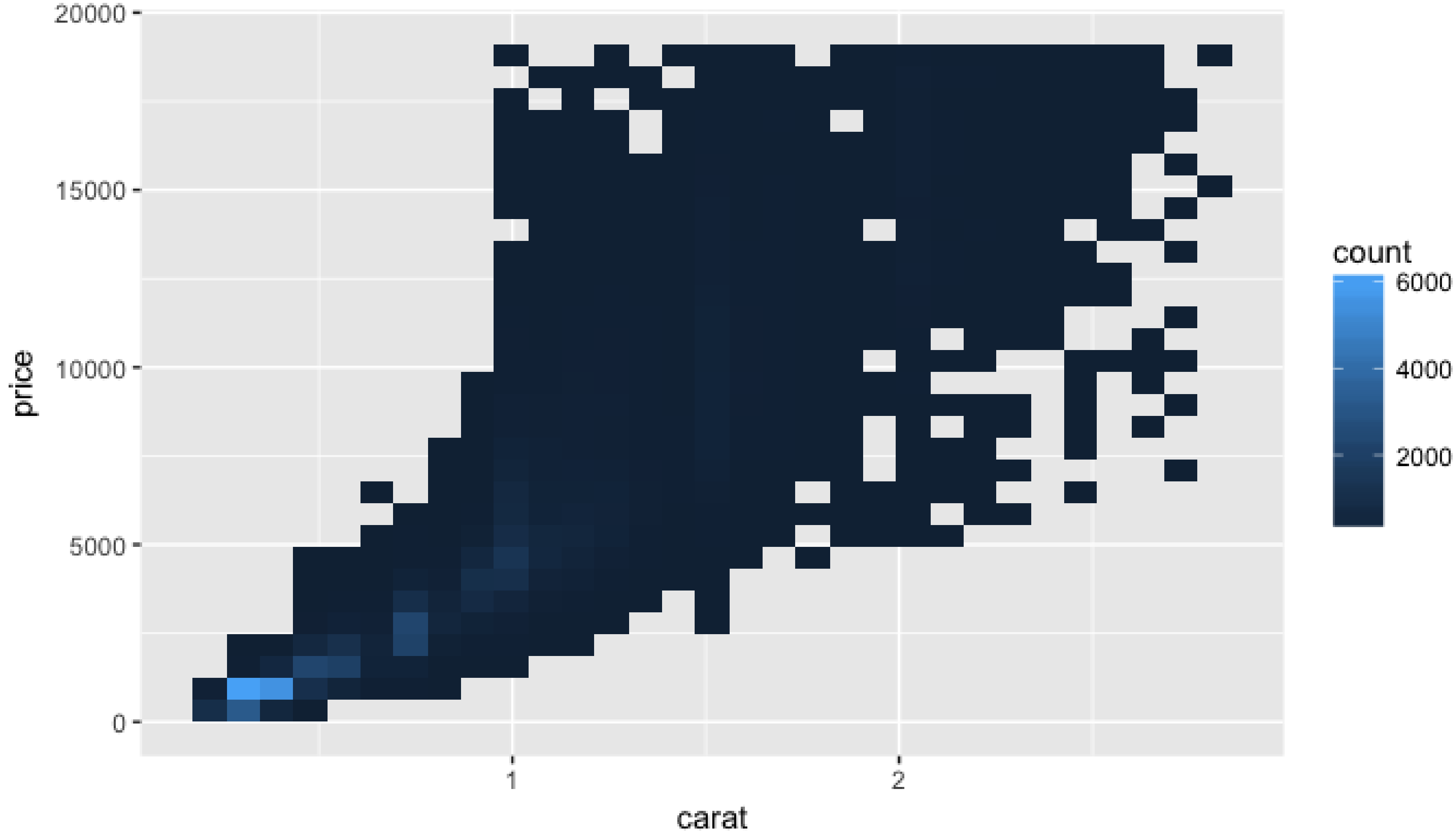

```
ggplot(data = diamonds) +  geom_point(mapping = aes(x = carat, y = price, color= clarity))
```

Mini Distributions: Carat vs Price



ggplot(data = diamonds) + geom_point(mapping = aes(x = carat, y = price,color= clarity, size = carat))

Mini Distributions: Carat vs Price




```
ggplot(data = smaller) +
  geom_bin2d(mapping = aes(x = carat, y = price))
```

Consider This: *plots*

Can you plot your diamond dataset with and without outliers?

Compare your plots.

Play with the binwidths: What is a good size of bin to use?

Time permitting, can you find another dataset to trim outliers?

```
diamonds3 <- diamonds %>%
  mutate(y = ifelse(y < ## | y > ##, NA, y))
```