Exploratory Data Analysis (EDA) in R

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Learning Objectives

- Strategies for EDA
- Chapter 7 of RDS

General Strategies

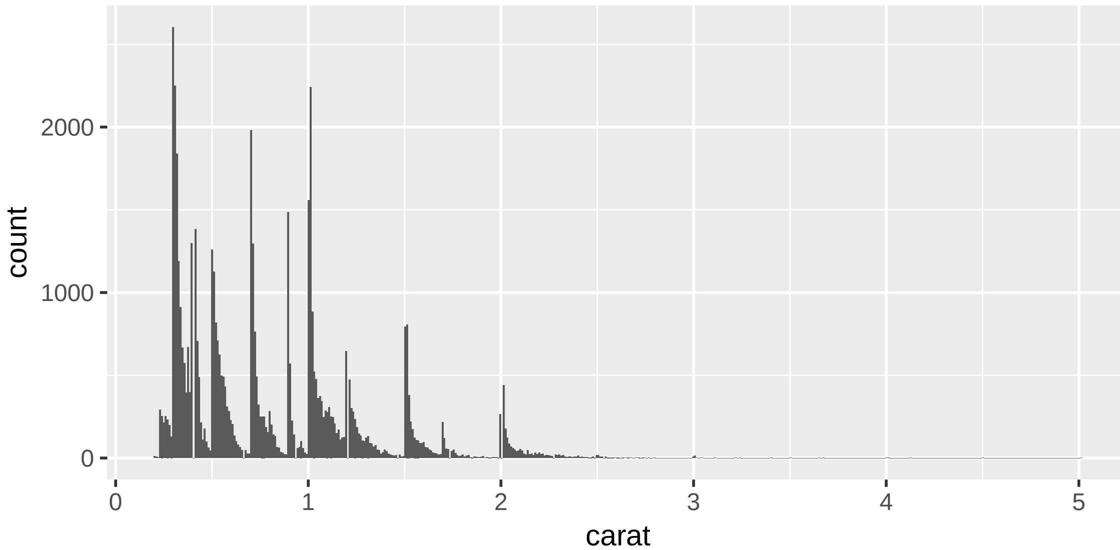
- Plot the distribution of every variable.
- Plot the bivariate distribution of every pair of variables (to find which variables are associated).
- Color code by variables to try and see if relationships can be explained.
- Calculate lots of summary statistics.
- Look at missingness.
- Look at outliers.
- EDA is about **curiosity**. Ask *many* questions, use *many* plots, investigate *many* aspects of your data. This will let you hone in on the few *interesting* questions you want to pursue deeper.

```
library(tidyverse)
data("diamonds")
```

Distribution of Every Variable:

- Quantitative: Use a histogram.
    - Look for modality. Indicates multiple groups of units. What can explain the modes? Can any of the other variables explain the modes?
    - Are certain values more likely than other values?
    - Look for skew.
    - `geom_histogram()`
    - Mean, median, standard deviation, five number summary.

    ```
    ggplot(data = diamonds, mapping = aes(x = carat)) +
      geom_histogram(bins = 500)
    ```




```
fivenum(diamonds$carat)
```

```
## [1] 0.20 0.40 0.70 1.04 5.01
```

```
mean(diamonds$carat)
```

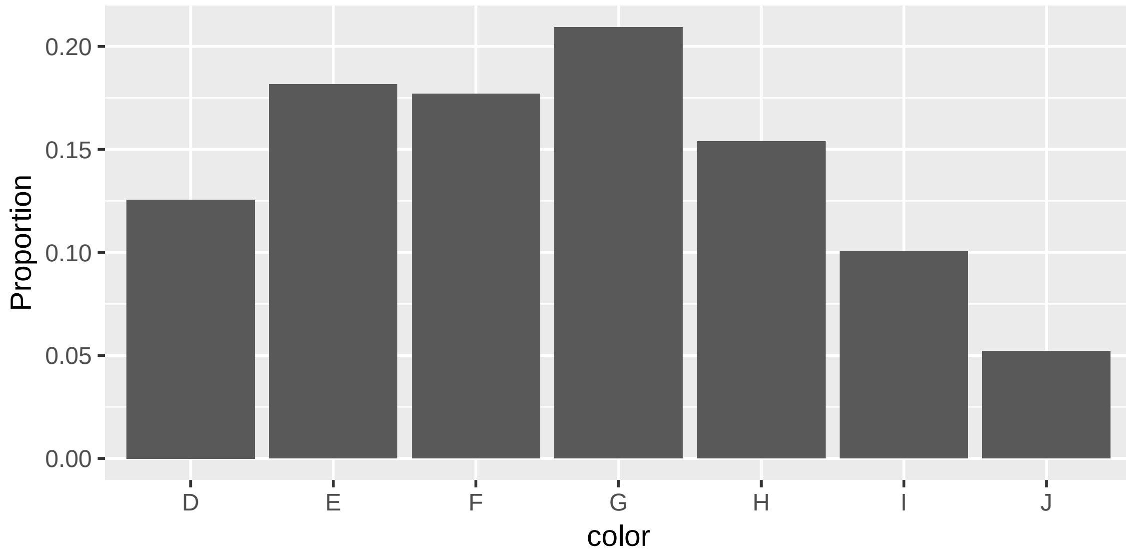
```
## [1] 0.7979
```

```
sd(diamonds$carat)
```

```
## [1] 0.474
```

- Categorical: Use a bar chart. Or just a table of *proportions* (`table()` then `prop.table()`).
  - Absolute counts are sometimes interesting, but usually you want to look at the proportion of observations in each category.
  - Is there a natural ordering of the categories (bad, medium, good)?
  - Why are some categories more represented than others?
  - `geom_bar()`, `geom_col()`
  - Proportion of observations within each group.

```
ggplot(diamonds, aes(x = color, y = ..)) +
  geom_bar(aes(y = ..count.. / sum(..count..))) +
  ylab("Proportion")
```




```r
table(diamonds$color)
```

```
##
##     D     E     F     G     H     I     J
##  6775  9797  9542 11292  8304  5422  2808
```

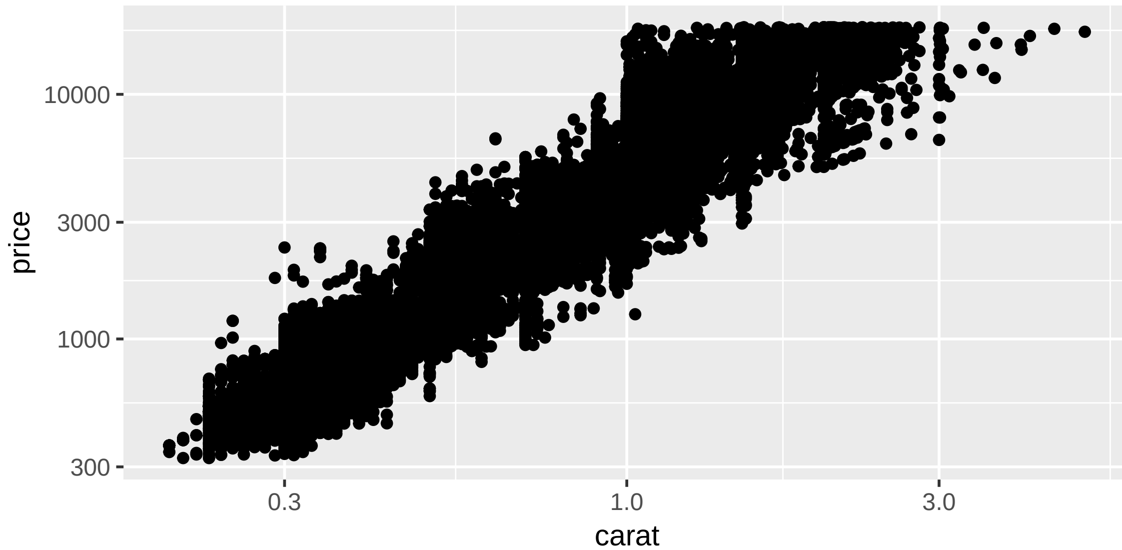
```r
prop.table(table(diamonds$color))
```

```
##
##       D       E       F       G       H       I       J
## 0.12560 0.18163 0.17690 0.20934 0.15395 0.10052 0.05206
```

Bivariate Distribution of Every Pair of Variables

- Quantitative vs Quantitative: Use a scatterplot
  - Is the relationship linear? Quadratic? Exponential?
  - Logging is useful tool to make some associations linear. If the relationship is (i) monotonic and (ii) curved, then try logging the x-variable *if the x-variable is all positive*. If it is also (iii) more variable at larger y-values, then try logging the y-variable *instead* of the x-variable *if the y-variable is all positive*. Try logging both if you still see curvature *if both variables are all positive*.
  - Ask if an observed association can be explained by another variable?
  - Correlation coefficient (only appropriate if association is linear).
  - Kendall's tau (always appropriate).

```r
ggplot(diamonds, aes(x = carat, y = price)) +
  geom_point() +
  scale_y_log10() +
  scale_x_log10()
```



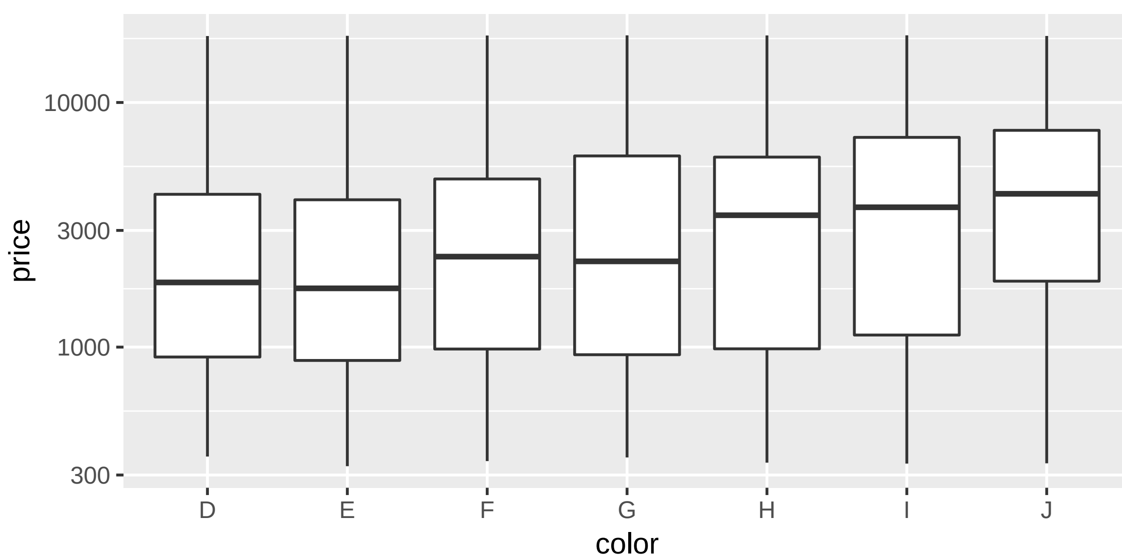

```
cor(diamonds$carat, diamonds$price)
```

```
## [1] 0.9216
```

```
## cor(diamonds$carat, diamonds$price, method = "kendall")
```

- Categorical vs Quantitative: Use a boxplot
  - For which levels of the categorical variable is the quantitative variable higher or lower?
  - For which levels is the quantitative variable more spread out?
  - Aggregated means, medians, standard deviations, quantiles

```
ggplot(diamonds, aes(x = color, y = price)) +
  geom_boxplot() +
  scale_y_log10()
```



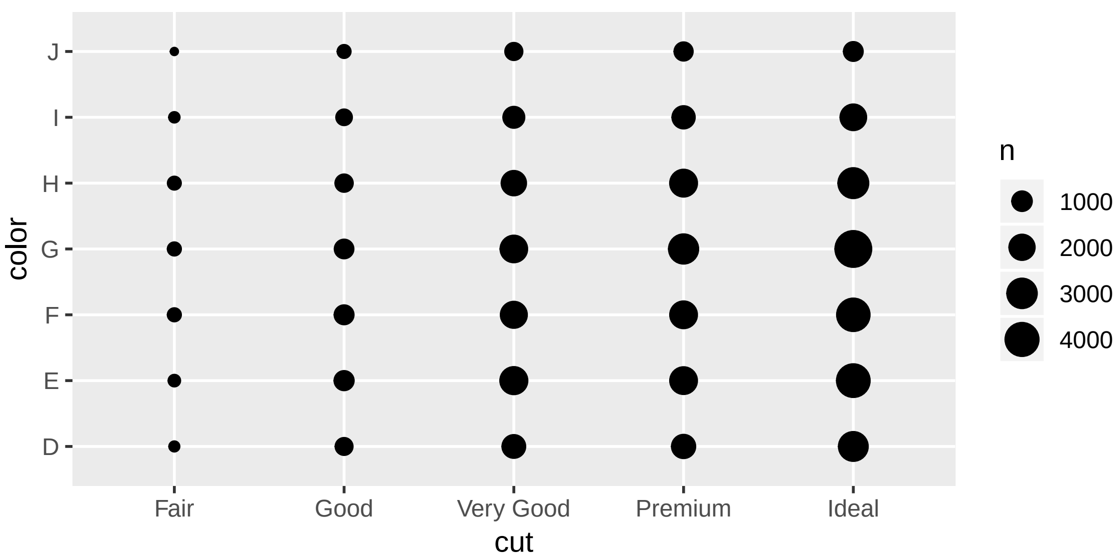

```
diamonds %>%
  mutate(logprice = log(price)) %>%
  group_by(color) %>%
```

```r
  summarize(mean   = mean(logprice),
            sd     = sd(logprice),
            median = median(logprice),
            Q1     = quantile(logprice, 0.25),
            Q3     = quantile(logprice, 0.75))
```

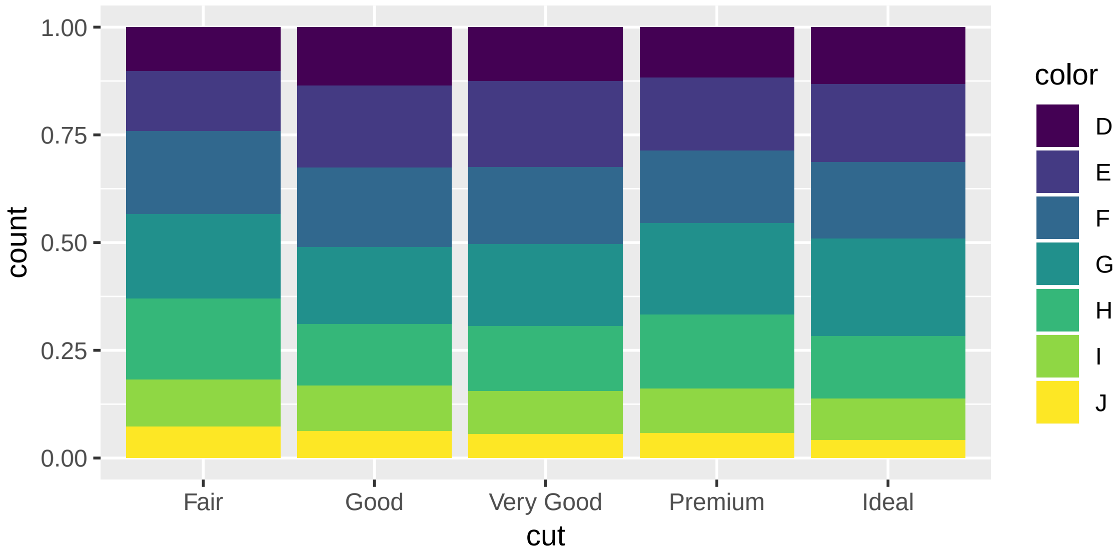
```
## # A tibble: 7 x 6
##   color  mean    sd median    Q1    Q3
##   <ord> <dbl> <dbl>  <dbl> <dbl> <dbl>
## 1 D      7.62 0.926   7.52  6.81  8.35
## 2 E      7.58 0.925   7.46  6.78  8.29
## 3 F      7.76 0.968   7.76  6.89  8.49
## 4 G      7.79 1.03    7.72  6.84  8.71
## 5 H      7.92 1.06    8.15  6.89  8.70
## 6 I      8.02 1.11    8.22  7.02  8.88
## 7 J      8.15 1.04    8.35  7.53  8.95
```

- Categorical vs Categorical: Use a mosaic plot or a count plot
  - For which pairs of values of the categorical variables are there the most number of units?
  - Does the conditional distribution of a categorical variable change at different levels of the other categorical variable?
  - `prop.table()`

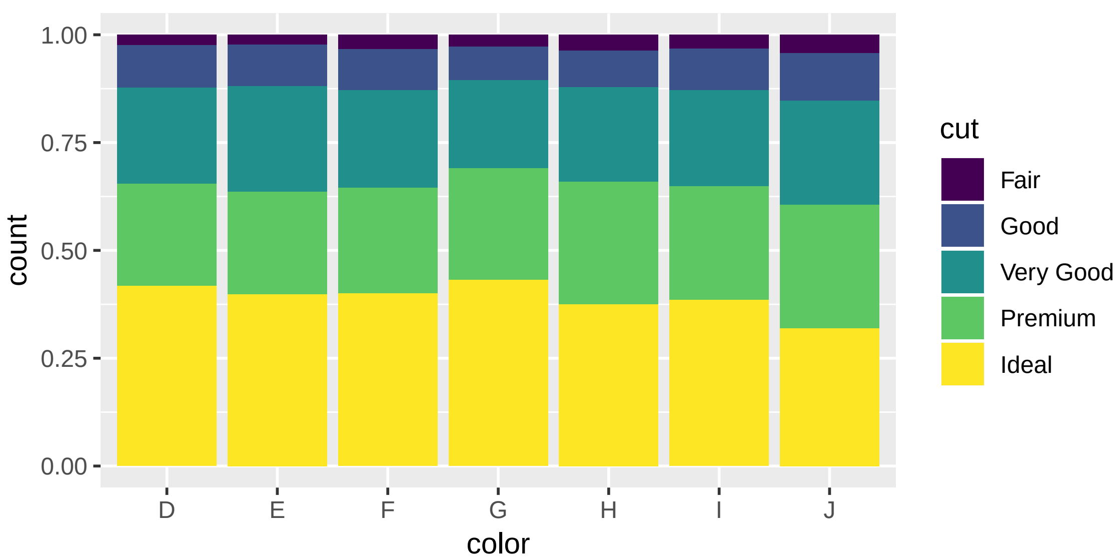
```r
## Only gives you the bivariate distribution
ggplot(diamonds, aes(x = cut, y = color)) +
  geom_count()
```




```r
## Gives you the conditional distributions of color given cut
ggplot(diamonds, aes(x = cut, fill = color)) +
  geom_bar(position = "fill")
```




```r
## Gives you the conditional distributions of cut given color
ggplot(diamonds, aes(x = color, fill = cut)) +
  geom_bar(position = "fill")
```




```r
## Bivariate Distribution
prop.table(table(diamonds$color, diamonds$cut))
```

```
##
##          Fair     Good Very Good  Premium    Ideal
##   D 0.003022 0.012273  0.028050 0.029718 0.052540
##   E 0.004153 0.017297  0.044494 0.043326 0.072358
##   F 0.005784 0.016852  0.040119 0.043215 0.070931
##   G 0.005821 0.016148  0.042621 0.054208 0.090545
##   H 0.005617 0.013014  0.033815 0.043752 0.057749
##   I 0.003244 0.009677  0.022321 0.026474 0.038802
##   J 0.002206 0.005692  0.012570 0.014980 0.016611
```

```r
##  Conditional distributions of column variable conditional on row variable
prop.table(table(diamonds$color, diamonds$cut), margin = 1)
```

```
##
##        Fair    Good Very Good Premium   Ideal
##   D 0.02406 0.09771   0.22332 0.23661 0.41830
##   E 0.02286 0.09523   0.24497 0.23854 0.39839
##   F 0.03270 0.09526   0.22679 0.24429 0.40096
##   G 0.02781 0.07713   0.20360 0.25894 0.43252
##   H 0.03649 0.08454   0.21965 0.28420 0.37512
##   I 0.03228 0.09627   0.22206 0.26337 0.38602
##   J 0.04238 0.10933   0.24145 0.28775 0.31909
```

```r
## Conditional distributions of row variable conditional on column variable
prop.table(table(diamonds$color, diamonds$cut), margin = 2)
```

```
##
##        Fair    Good Very Good Premium   Ideal
##   D 0.10124 0.13494   0.12523 0.11624 0.13150
##   E 0.13913 0.19018   0.19864 0.16946 0.18111
##   F 0.19379 0.18528   0.17911 0.16902 0.17753
##   G 0.19503 0.17754   0.19028 0.21202 0.22663
##   H 0.18820 0.14309   0.15097 0.17113 0.14454
##   I 0.10870 0.10640   0.09965 0.10355 0.09712
##   J 0.07391 0.06258   0.05612 0.05859 0.04158
```