Examining Covariations Between Variables

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This coding exercise was from the Program Evaluation and Data Analysis course taught by Dr. Nelson Lim at the University of Pennsylvania. Data was provided by the instructor.

Key Packages

```
library(tidyverse)
library(readr)
library(ggplot2)
library(ggthemes)
```

Bi-Variate or Multivariate Covariations

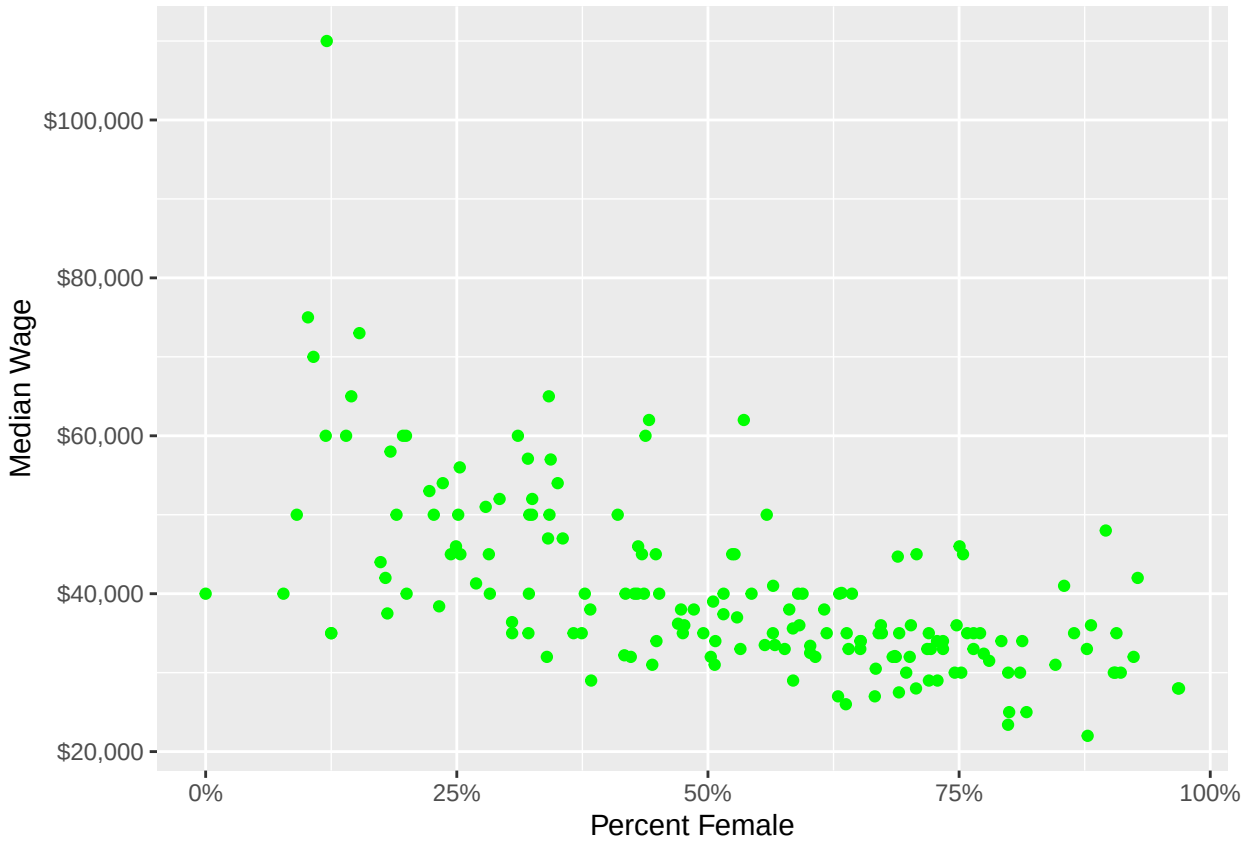
First step toward determine causality. Important to determine input-output, independent-dependent relationship between the variables, and design the visualization and analysis based on that determinant.

Covariation between continuous variables

Create scatterplot

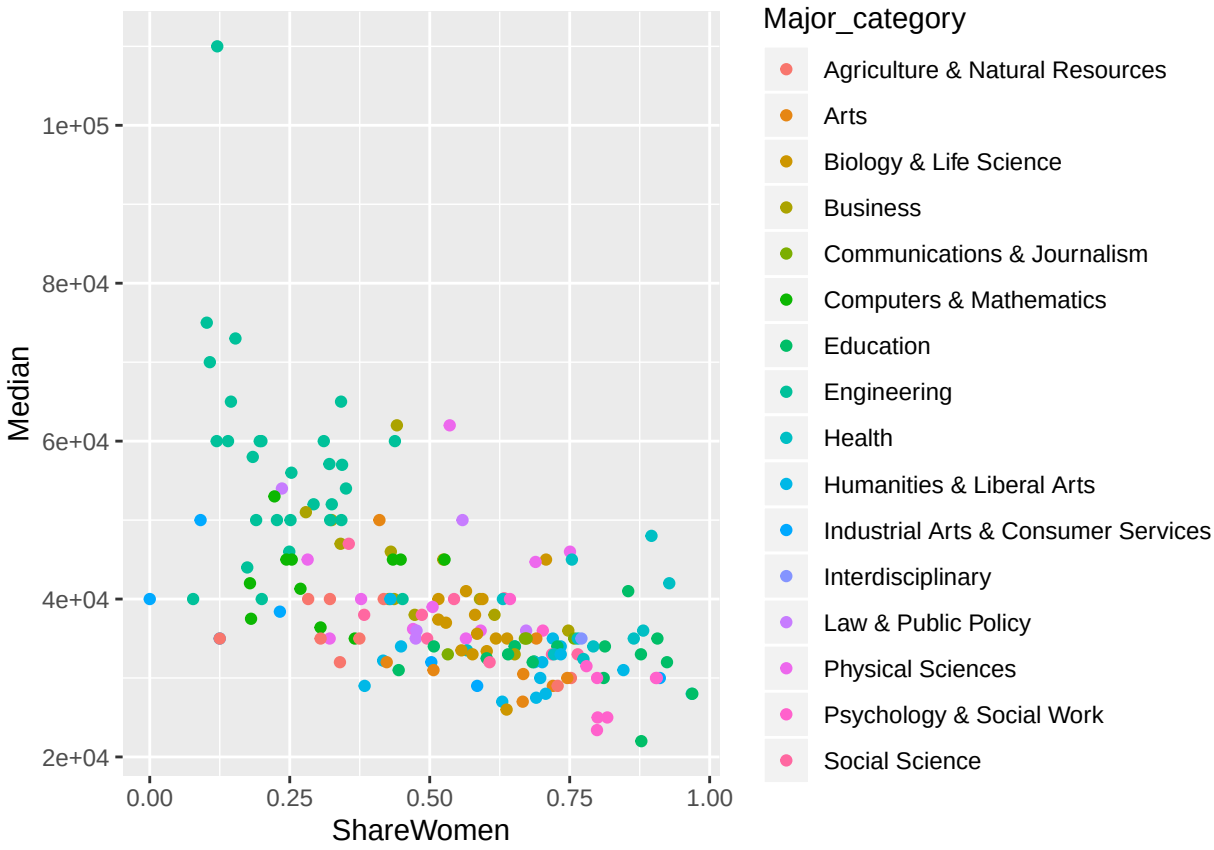
Visualize covariation between the representation of females in a college major and the median income of the the major. Data taken from fivethirtyeight.

```
college_major <- read.csv("recent-grads.csv")

ggplot(data = college_major) + geom_point(mapping = aes(x=ShareWomen, y=Median), color = "green") +

      # Format x and y labels
        scale_x_continuous(name = "Percent Female", labels = scales::percent) +
        scale_y_continuous(name = "Median Wage", labels = scales::dollar)
```



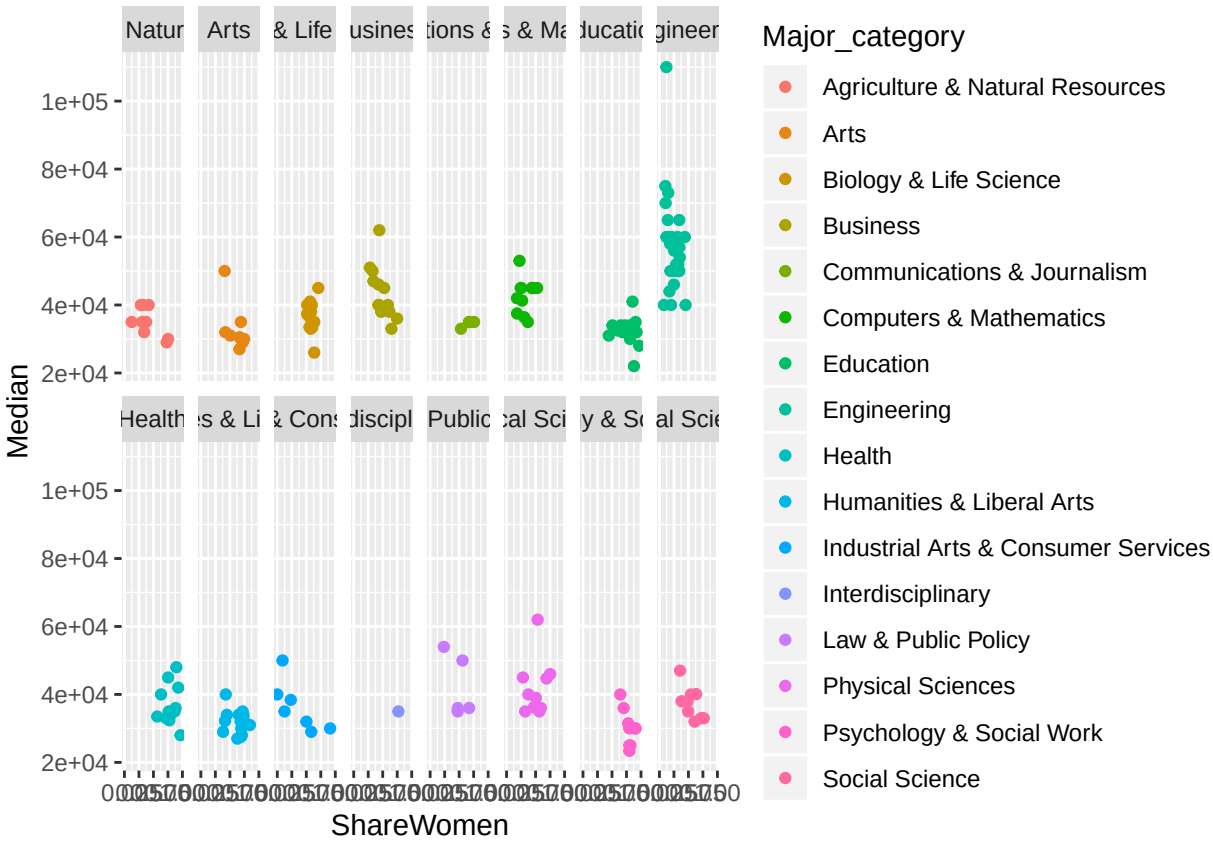
Add third dimension to the plot

```
ggplot(college_major) + geom_point(aes(x = ShareWomen, y = Median, color = Major_category))
```



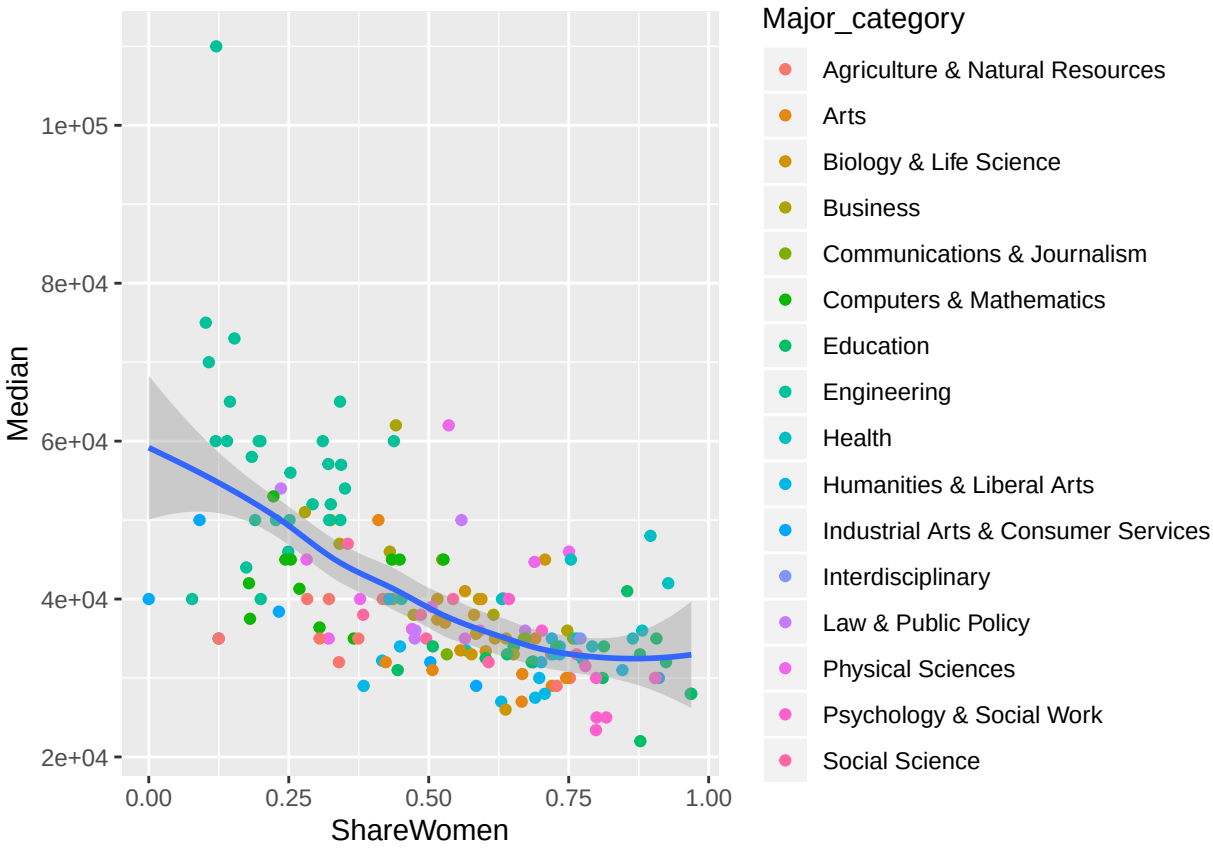
Facets

```
ggplot(data = college_major) +
    geom_point(mapping = aes (x = ShareWomen, y = Median, color = Major_category)) +
    facet_wrap(~Major_category, nrow = 2)
```



Multivariate scatterplot with regression lines

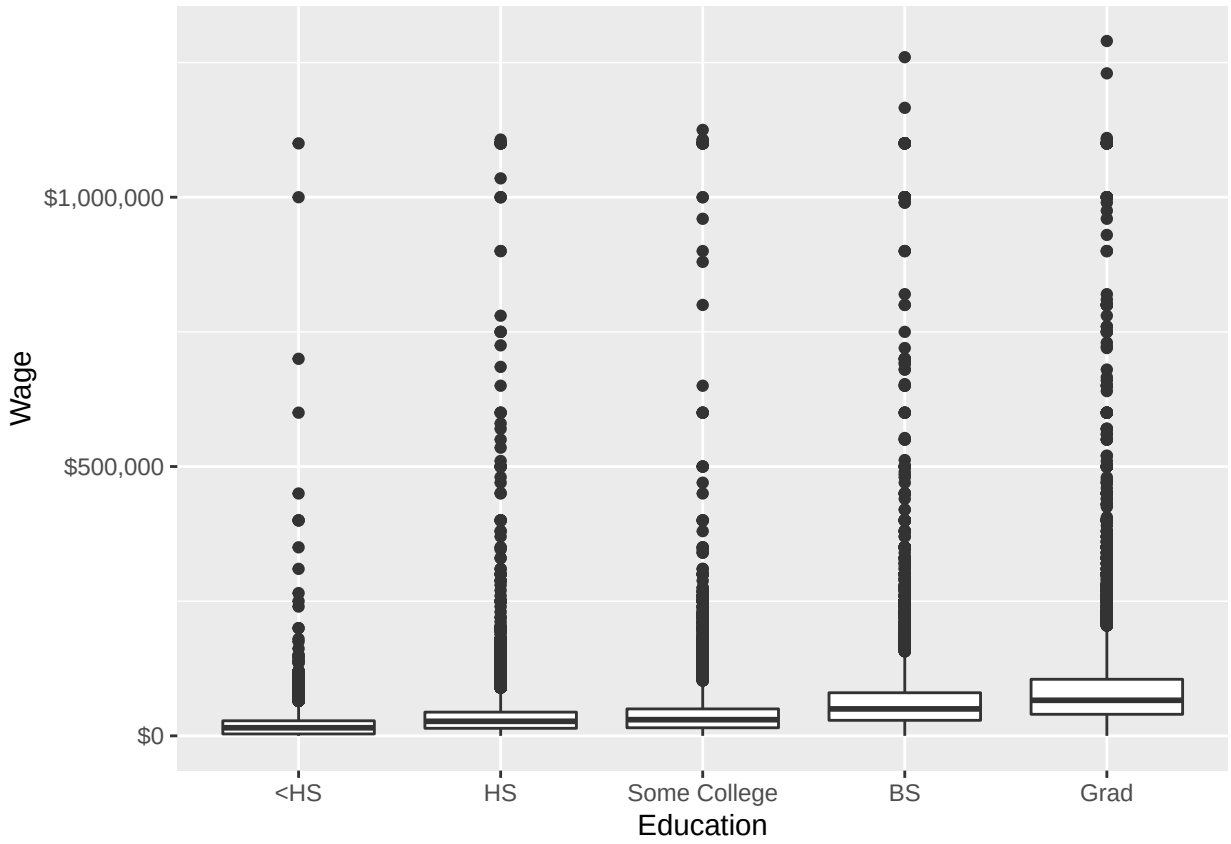
```
ggplot(data = college_major) +
   geom_point(mapping = aes(x=ShareWomen, y=Median, color=Major_category)) +
   geom_smooth(aes(x=ShareWomen, y=Median))
```



Boxplot

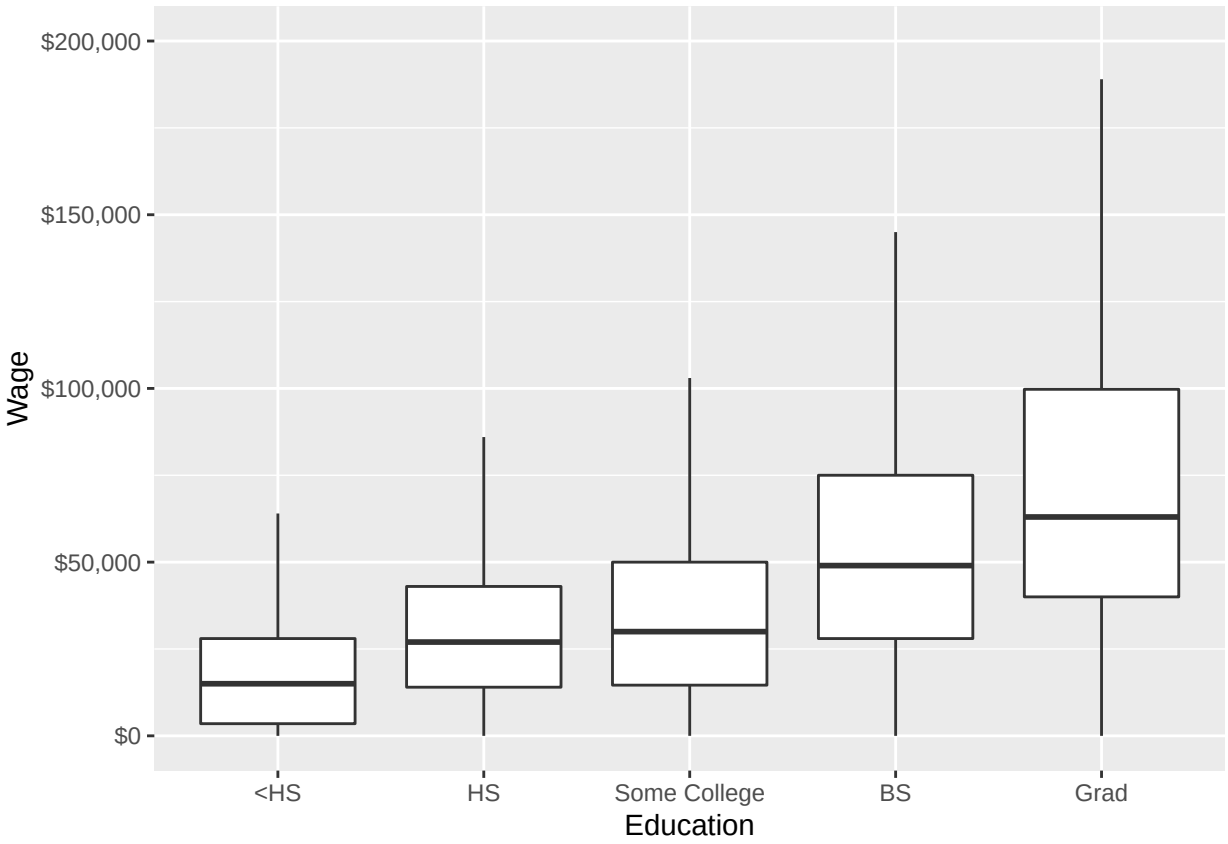
Bin continuous variable to act like a categorical variable. Plot covariation between degree and wage. Data taken from the US Bureau of Labor Statistics' Current Population Survey.

```
cps_small <- readRDS("cps-2017-small.rds")

# Adjust bin for "Yrs_Schooling"
  cps_small <- cps_small %>% drop_na(Yrs_Schooling) %>%
                             mutate(Degree = cut(Yrs_Schooling, breaks=c(-Inf, 11, 12, 15, 16, 20),
                                    labels = c("<HS","HS","Some College", "BS", "Grad")))

# Plot
  ggplot(data = cps_small, mapping = aes(x = Degree, y = Wage)) +
    geom_boxplot() +
    scale_x_discrete(name = "Education") +
    scale_y_continuous(name = "Wage", labels = scales::dollar)
```



Remove the outliers and zoom in and see the relationship better

```
ggplot(data = cps_small, mapping = aes(x = Degree, y = Wage)) +
  geom_boxplot(outlier.shape = NA) +
  scale_x_discrete(name = "Education") +
  scale_y_continuous(name = "Wage", labels = scales::dollar, limits = c(0, 200000))
```

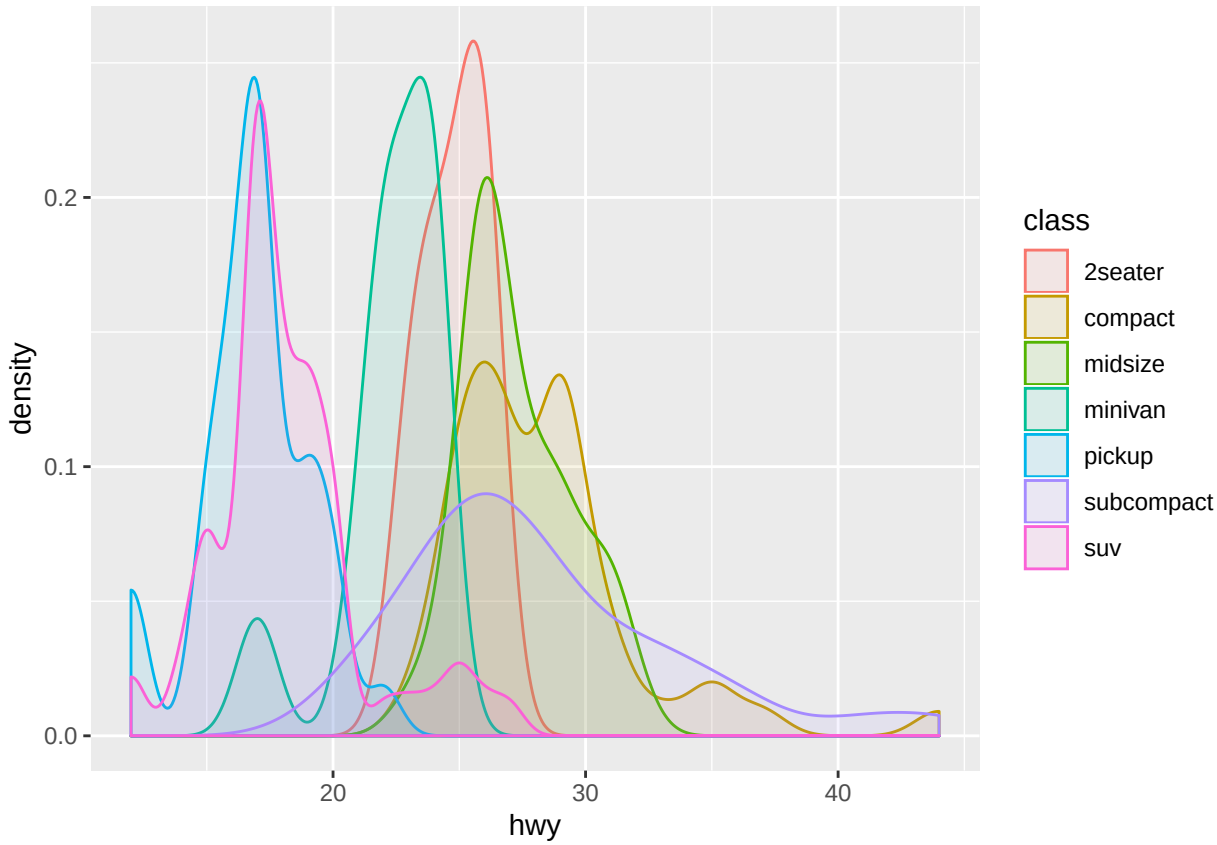


Covariation Between Categorical & Continuous Variable

Explore the distribution of a continuous variable broken down by categorical variable.

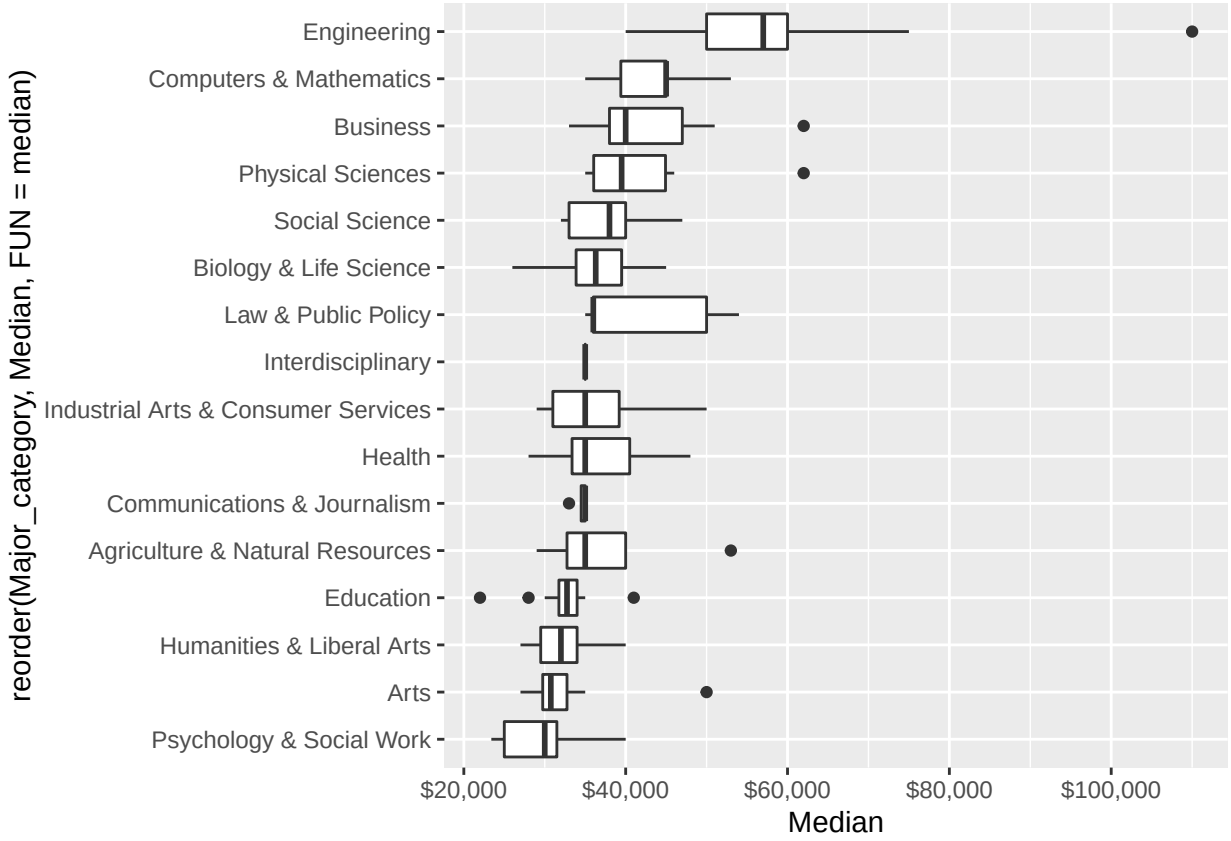
Density plot

```
#categorical = input/x
#continuous = output/y

ggplot(mpg, aes(hwy, fill=class, colour=class)) + geom_density(alpha=0.1)
```



Box plot

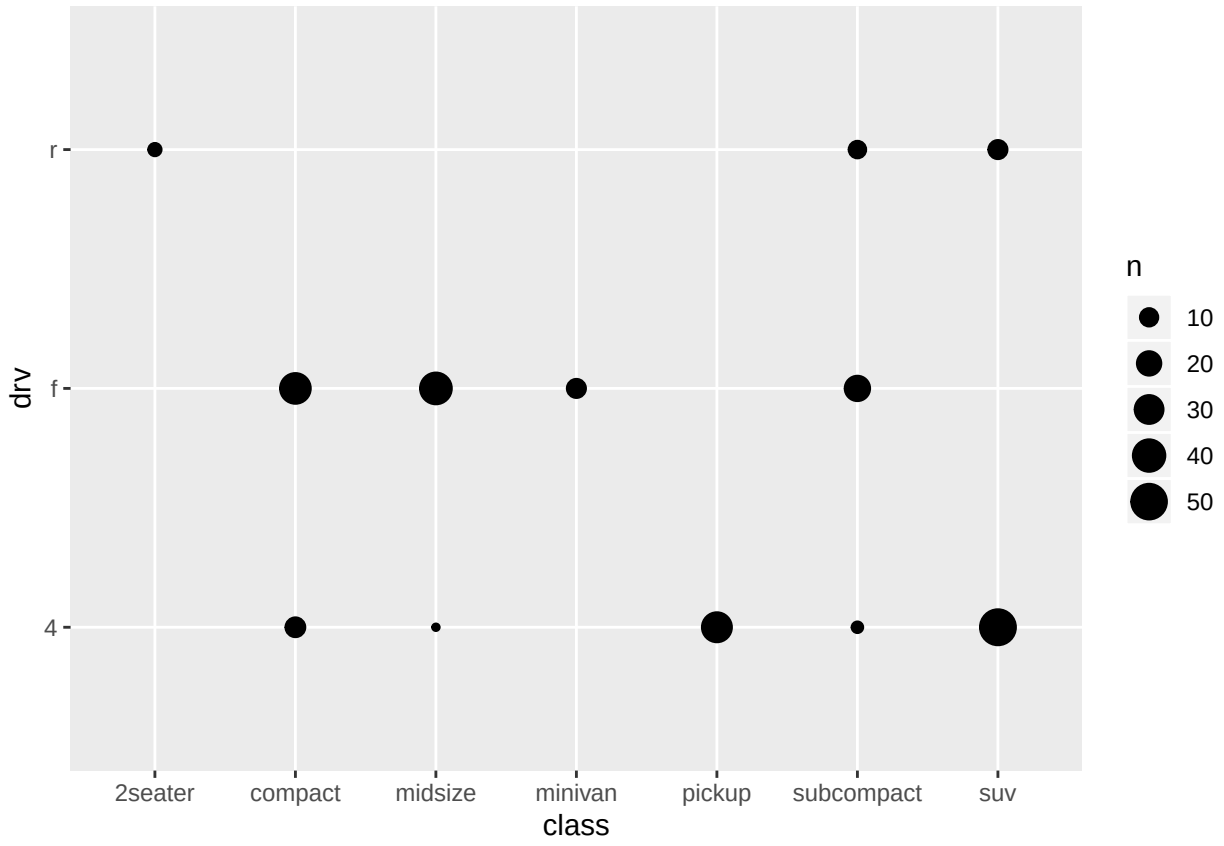
```
ggplot(data = college_major) +

  # sort majors highest to lowest median salary
  geom_boxplot(mapping = aes(x=reorder(Major_category, Median, FUN=median), y=Median)) +

  #flip the axes
  coord_flip() + #flip the axes

  #remove scientific notation
  scale_y_continuous(labels=scales::dollar)
```



Covariation between two categorical variables

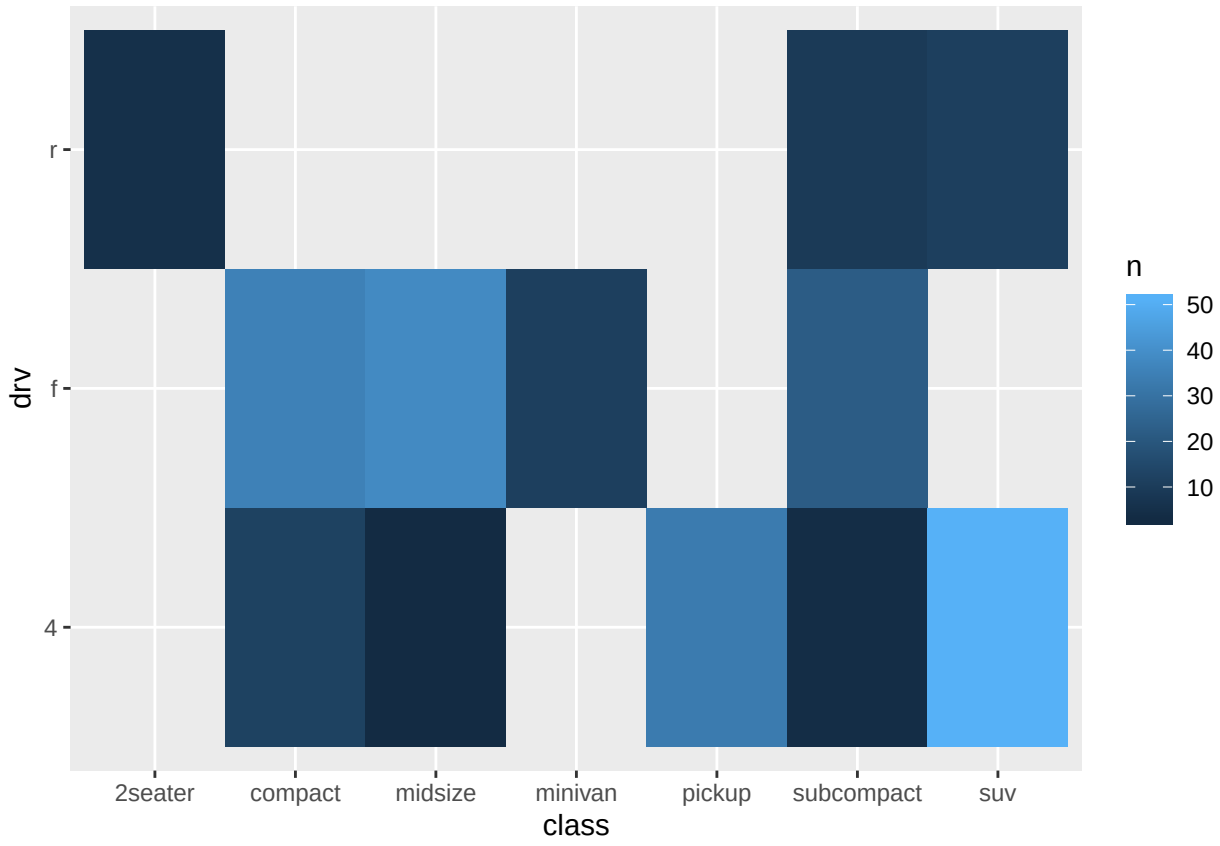
Circles

```
ggplot(data = mpg) + geom_count(mapping = aes(x=class, y=drv))
```



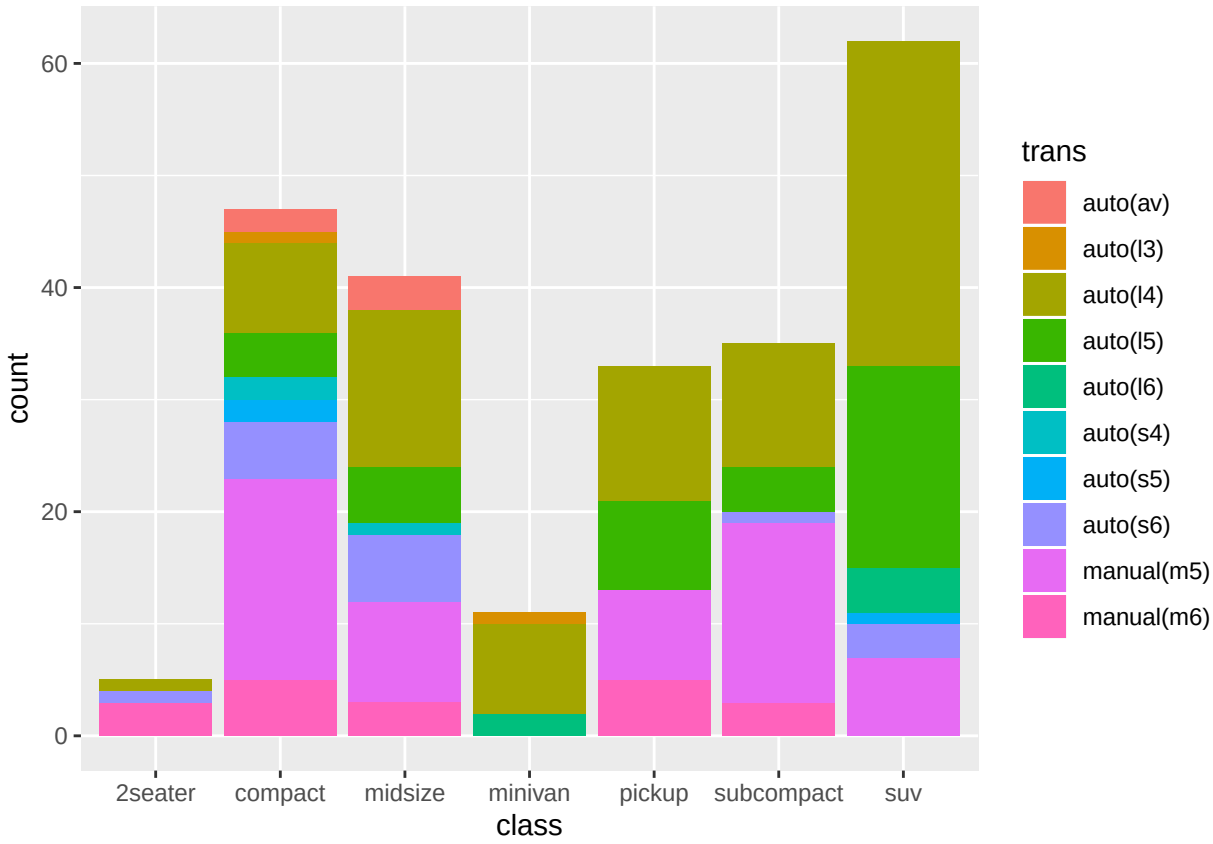
Tiles

```
mpg %>%
  count(class,drv) %>%
  ggplot(mapping=aes(x=class, y=drv)) +
  geom_tile(mapping = aes(fill=n))
```



Stacked Bar Graph

```
ggplot(data = mpg) + geom_bar(mapping = aes(x=class, fill=trans))
```



Formatting Exercise

Difference in wage distributions across states

```
ggplot(data = cps_small) +
    geom_smooth(mapping = aes(x = Yrs_Schooling, y = Wage, colour = Sex)) +

  #add title, subtitle, caption
  labs(
    title = "Gender gap in wages increase with the level of education in 2017",
    subtitle = "On average, women earn less than men across all levels of education",
    caption = "Source: Current Population Survey") +

  #add annotations
  annotate("text", x = 8, y = 55000, label = "Non-linear regression lines with standard errors") +

  #format labels
  scale_x_continuous(name = "Education (Years of Schooling)", breaks = seq(0, 20, 2)) +
  scale_y_continuous(name = "Wage", breaks = seq(0, 150000, 25000), labels = scales::dollar) +

  #format line color
  scale_color_manual(values = c(Male="red", Female="blue"), labels=c("Men", "Women")) +

  #format grid lines
  theme(
```

```
    panel.grid.major = element_line(size=.5, linetype = 'solid', colour = "White"),
    panel.grid.minor = element_line(size = 0.25, linetype = 'solid', colour = "White")
  )
```