Chapter 2 Workshop

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Dataset `Prestige`

As you work through this workshop, you can copy the code and paste it into a code chunk. Write notes and observations to your self as you go.

We will be using a well-known dataset called `Prestige` from the `car` R package. This dataset deals with prestige ratings of Canadian occupations. The `Prestige` dataset has 102 rows and 6 columns. Each row (or 'observation') is an occupation.

This data frame contains the following columns:

- `education` - Average education of occupational incumbents, years, in 1971.
- `income` - Average income of incumbents, dollars, in 1971.
- `women` - Percentage of incumbents who are women.
- `prestige` - Pineo-Porter prestige score for occupation, from a social survey conducted in the mid-1960s.
- `census` - Canadian Census occupational code.
- `type` - Type of occupation. A factor with levels: bc, Blue Collar; prof, Professional, Managerial, and Technical; wc, White Collar. (includes four missing values).

First we'll load the data. The dataset sits in the `car` package, so you need to load the `car` package first.

```r
library(car)
data(Prestige)
```

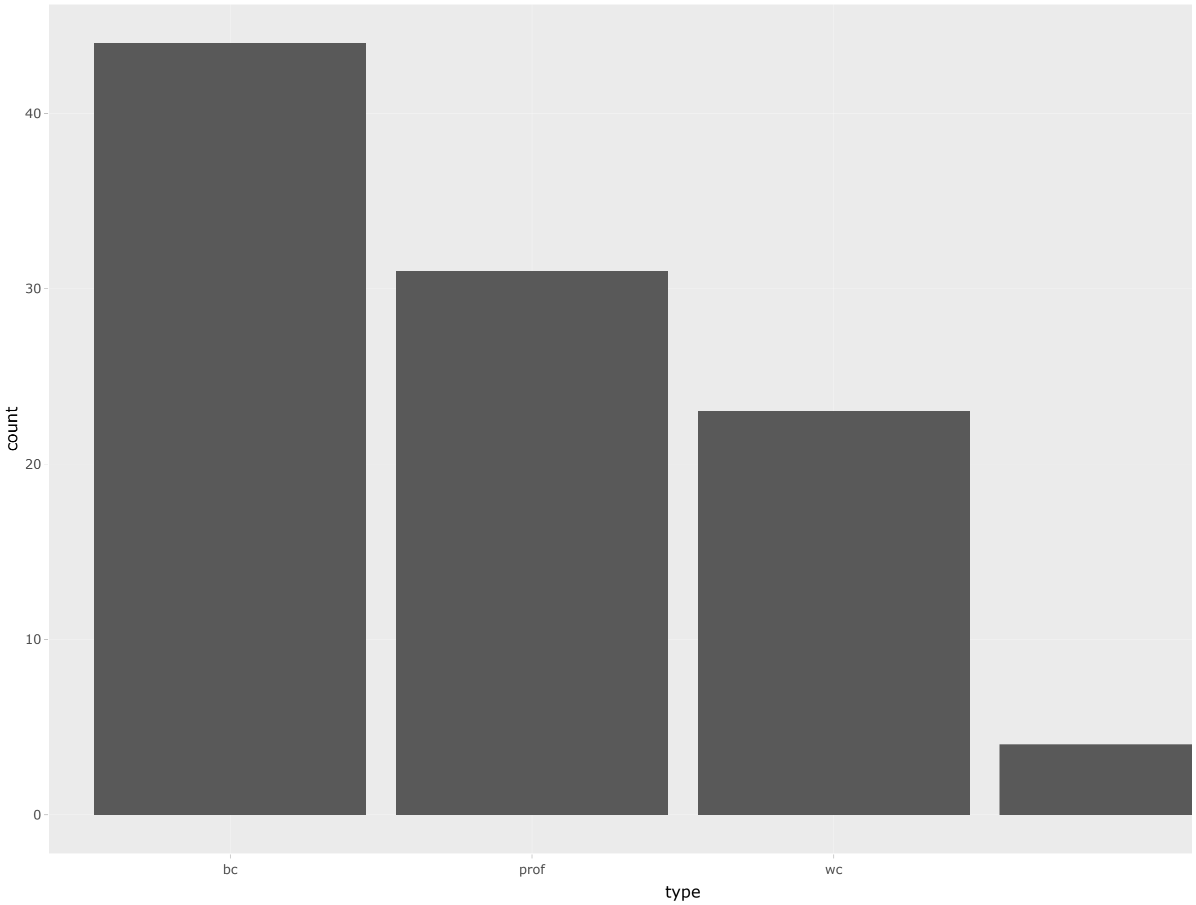
Exercise 2.1

Draw a bar chart for `type`. These plots show the count or relative frequency of blue collar (`bc`), professional (`prof`), and white collar (`wc`) professions in the dataset.

```r
library(tidyverse)

p <- Prestige |>
  ggplot() +
  aes(type) +
  geom_bar()

p
```

Or with `plotly` (which works for HTML, not for PDF)

```r
library(plotly)

ggplotly(p)
```



Or with old-style R plot

```
# or
library(car)
barplot(table(Prestige$type))
```

Exercise 2.2

Draw a histogram of `prestige`.

Below demonstrates the flexibility of `ggplot` code. You can specify the `data` argument by piping it into `ggplot`, or by putting it as an argument to `ggplot` or a `geom_`. Likewise, the `mapping` or `aes` information, which determines which variables are used where, can be added as an extra line or specified inside the `ggplot` or `geom_` function.

```
Prestige |>
  ggplot() +
  aes(x = prestige) +
  geom_histogram()
```

Now, this histogram, where the number of bins has been chosen for us, looks a bit "spiky" to my eye. You can control the number of bins by adding an argument `bins = 10`.

```
Prestige |>
  ggplot() +
  aes(x = prestige) +
  geom_histogram(bins=10)
```

`ggplot` is very flexible as to where you put the data and the `aes` information; all of these methods give the same result.

```
Prestige |>
  ggplot() +
  aes(x = prestige) +
  geom_histogram(bins=10)
```

```
ggplot(
  data = Prestige,
  mapping = aes(x = prestige)
  ) +
  geom_histogram(bins=10)
```

```r
ggplot(Prestige) +
  aes(x = prestige) +
  geom_histogram(bins=10)
```

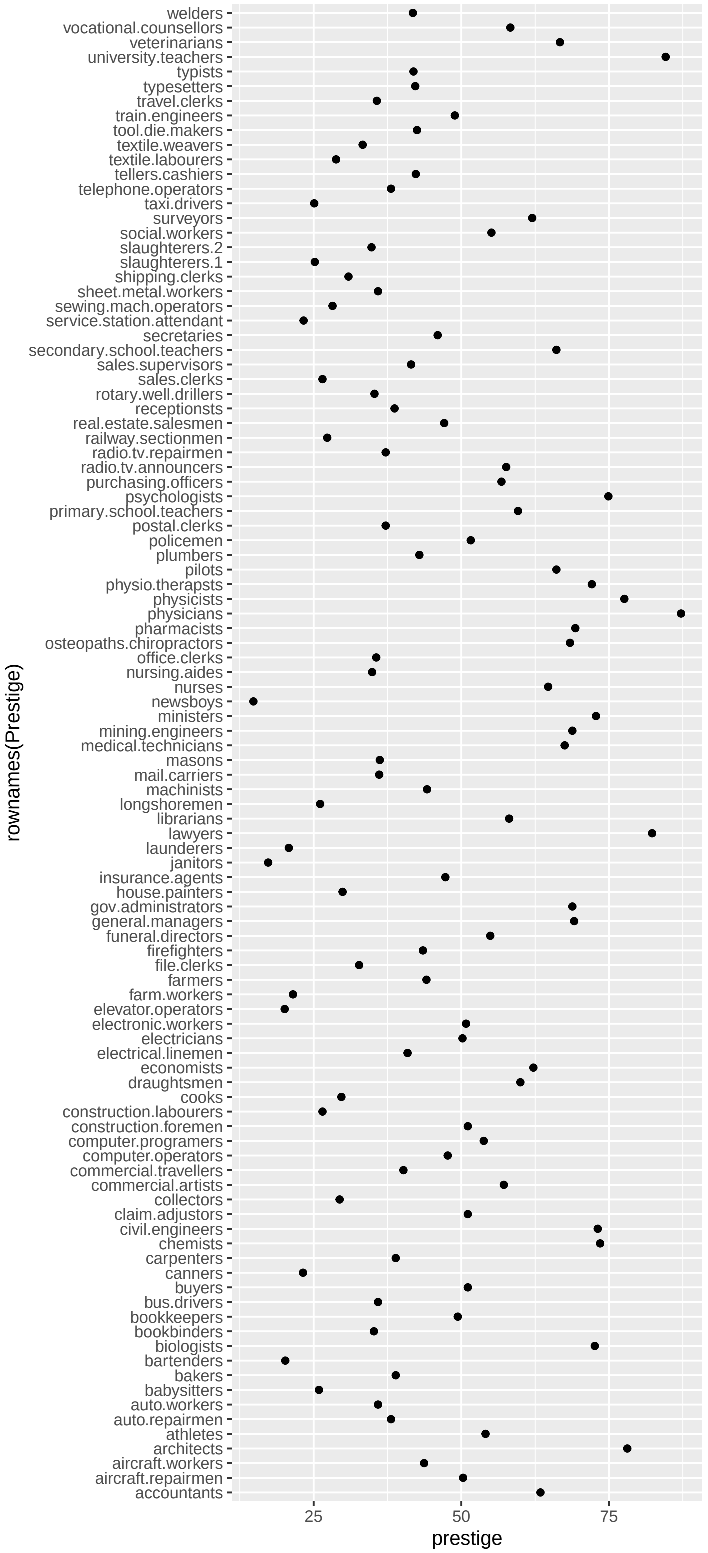
```r
ggplot() +
  geom_histogram(
    data = Prestige,
    mapping = aes(x = prestige),
    bins = 10
    )
```

```r
# or
# library(plotly)
# p <- Prestige |>
#   ggplot() +
#   aes(prestige) +
#   geom_histogram(bins=10)
#
# ggplotly(p)

# or
# hist(Prestige$prestige)
```

Now let's display the prestige scores for each profession as a dot plot.

Note that I'm including the code-chunk option `#| fig-height: 12` at the beginning of my code chunk so that the plot is big enough to show all the professions without overlap.

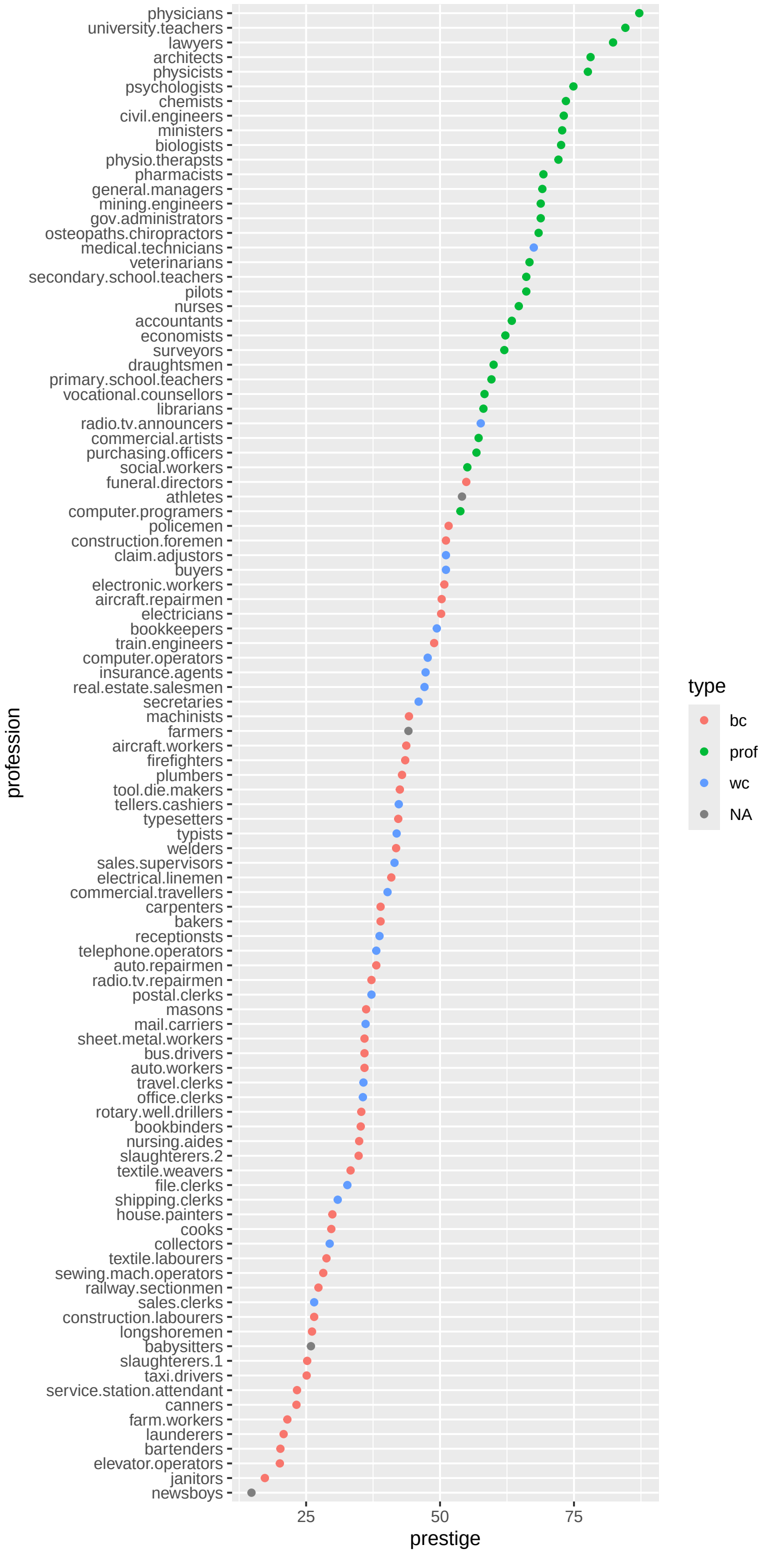
```r
Prestige |>
  ggplot() +
  aes(x = rownames(Prestige), y = prestige) +
  geom_point() +
  coord_flip()
```


welders
vocational.counsellors
veterinarians
university.teachers
typists
typesetters
travel.clerks
train.engineers
tool.die.makers
textile.weavers
textile.labourers
tellers.cashiers
telephone.operators
taxi.drivers
surveyors
social.workers
slaughterers.2
slaughterers.1
shipping.clerks
sheet.metal.workers
sewing.mach.operators
service.station.attendant
secretaries
secondary.school.teachers
sales.supervisors
sales.clerks
rotary.well.drillers
receptionsts
real.estate.salesmen
railway.sectionmen
radio.tv.repairmen
radio.tv.announcers
purchasing.officers
psychologists
primary.school.teachers
postal.clerks
policemen
plumbers
pilots
physio.therapsts
physicists
physicians
pharmacists
osteopaths.chiropractors
office.clerks
nursing.aides
nurses
newsboys
ministers
mining.engineers
medical.technicians
masons
mail.carriers
machinists
longshoremen
librarians
lawyers
launderers
janitors
insurance.agents
house.painters
gov.administrators
general.managers
funeral.directors
firefighters
file.clerks
farmers
farm.workers
elevator.operators
electronic.workers
electricians
electrical.linemen
economists
draughtsmen
cooks
construction.labourers
construction.foremen
computer.programers
computer.operators
commercial.travellers
commercial.artists
collectors
claim.adjustors
civil.engineers
chemists
carpenters
canners
buyers
bus.drivers
bookkeepers
bookbinders
biologists
bartenders
bakers
babysitters
auto.workers
auto.repairmen
athletes
architects
aircraft.workers
aircraft.repairmen
accountants
rownames(Prestige)
25
50
75
prestige

What a mess!

We can tidy it up by ordering the professions on the plot according to `prestige`. First, we move the professions from rownames to a variable. Then, we `fct_reorder` the professions using the `prestige` scores. Then, the resulting data gets piped into `ggplot`.

```r
Prestige |>
  rownames_to_column(var = "profession") |>
  mutate(
    profession = fct_reorder(profession, prestige)
    ) |>
  ggplot() +
  aes(x = profession, y = prestige, colour = type) +
  geom_point() +
  coord_flip()
```


physicians
university.teachers
lawyers
architects
physicists
psychologists
chemists
civil.engineers
ministers
biologists
physio.therapsts
pharmacists
general.managers
mining.engineers
gov.administrators
osteopaths.chiropractors
medical.technicians
veterinarians
secondary.school.teachers
pilots
nurses
accountants
economists
surveyors
draughtsmen
primary.school.teachers
vocational.counsellors
librarians
radio.tv.announcers
commercial.artists
purchasing.officers
social.workers
funeral.directors
athletes
computer.programers
policemen
construction.foremen
claim.adjustors
buyers
electronic.workers
aircraft.repairmen
electricians
bookkeepers
train.engineers
computer.operators
insurance.agents
real.estate.salesmen
secretaries
machinists
farmers
aircraft.workers
firefighters
plumbers
tool.die.makers
tellers.cashiers
typesetters
typists
welders
sales.supervisors
electrical.linemen
commercial.travellers
carpenters
bakers
receptionists
telephone.operators
auto.repairmen
radio.tv.repairmen
postal.clerks
masons
mail.carriers
sheet.metal.workers
bus.drivers
auto.workers
travel.clerks
office.clerks
rotary.well.drillers
bookbinders
nursing.aides
slaughterers.2
textile.weavers
file.clerks
shipping.clerks
house.painters
cooks
collectors
textile.labourers
sewing.mach.operators
railway.sectionmen
sales.clerks
construction.labourers
longshoremen
babysitters
slaughterers.1
taxi.drivers
service.station.attendant
canners
farm.workers
launderers
bartenders
elevator.operators
janitors
newsboys
profession
25
50
75
prestige
type
bc
prof
wc
NA

Exercise 2.3

a) Obtain some summary statistics for `prestige`. There are a few options for this.

```
summary(Prestige)
```

```
   education          income          women           prestige    
 Min.   : 6.380   Min.   :  611   Min.   : 0.000   Min.   :14.80  
 1st Qu.: 8.445   1st Qu.: 4106   1st Qu.: 3.592   1st Qu.:35.23  
 Median :10.540   Median : 5930   Median :13.600   Median :43.60  
 Mean   :10.738   Mean   : 6798   Mean   :28.979   Mean   :46.83  
 3rd Qu.:12.648   3rd Qu.: 8187   3rd Qu.:52.203   3rd Qu.:59.27  
 Max.   :15.970   Max.   :25879   Max.   :97.510   Max.   :87.20  
     census       type   
 Min.   :1113   bc  :44  
 1st Qu.:3120   prof:31  
 Median :5135   wc  :23  
 Mean   :5402   NA's: 4  
 3rd Qu.:8312            
 Max.   :9517            
```

```
library(psych)

describe(Prestige)
```

```
          vars   n    mean      sd  median trimmed     mad     min      max
education    1 102   10.74    2.73   10.54   10.63    3.15    6.38    15.97
income       2 102 6797.90 4245.92 5930.50 6161.49 3060.83  611.00 25879.00
women        3 102   28.98   31.72   13.60   24.74   18.73    0.00    97.51
prestige     4 102   46.83   17.20   43.60   46.20   19.20   14.80    87.20
census       5 102 5401.77 2644.99 5135.00 5393.87 4097.91 1113.00  9517.00
type*        6  98    1.79    0.80    2.00    1.74    1.48    1.00     3.00
             range skew kurtosis     se
education     9.59 0.32    -1.03   0.27
income    25268.00 2.13     6.29 420.41
```

```
women        97.51 0.90    -0.68   3.14
prestige     72.40 0.33    -0.79   1.70
census     8404.00 0.11    -1.49 261.89
type*         2.00 0.40    -1.36   0.08
```

```
describeBy(education + income + women + prestige ~ type,
           data = Prestige)
```

```
 Descriptive statistics by group
type: bc
          vars  n    mean      sd  median trimmed     mad     min     max
education    1 44    8.36    1.16    8.35    8.32    1.14    6.38   10.93
income       2 44 5374.14 2004.33 5216.50 5338.56 2275.05 1656.00 8895.00
women        3 44   18.97   26.15    4.72   14.48    7.01    0.00   90.67
prestige     4 44   35.53   10.02   35.90   35.46   11.34   17.30   54.90
            range skew kurtosis     se
education    4.55 0.34    -0.76   0.18
income    7239.00 0.17    -1.00 302.16
women       90.67 1.36     0.51   3.94
prestige    37.60 0.05    -1.03   1.51
------------------------------------------------------------
type: prof
          vars  n     mean      sd  median trimmed     mad     min      max
education    1 31    14.08    1.39   14.44   14.16    1.22   11.09    15.97
income       2 31 10559.45 5422.82 8865.00 9700.04 3955.58 4614.00 25879.00
women        3 31    25.51   28.37   11.68   21.03   13.86    0.58    96.12
prestige     4 31    67.85    8.68   68.40   67.34    9.19   53.80    87.20
             range  skew kurtosis     se
education     4.88 -0.47    -0.93   0.25
income    21265.00  1.37     1.36 973.97
women        95.54  1.14    -0.04   5.09
prestige     33.40  0.36    -0.67   1.56
------------------------------------------------------------
type: wc
          vars  n    mean      sd  median trimmed     mad     min     max
education    1 23   11.02    0.92   11.13   11.03    0.68    9.17   12.79
income       2 23 5052.30 1944.32 4741.00 4960.53 2342.51 2448.00 8780.00
women        3 23   52.83   33.11   56.10   53.19   47.77    3.16   97.51
prestige     4 23   42.24    9.52   41.50   41.61    8.60   26.50   67.50
            range  skew kurtosis     se
education    3.62 -0.20    -0.27   0.19
```

```
income    6332.00  0.44    -1.18 405.42
women       94.35 -0.10    -1.58   6.90
prestige    41.00  0.63     0.18   1.98
```

b) Make a summary dataset, average variable for each type of occupation.

Exercise 2.4

Make a boxplot of `prestige ~ type`:

```
Prestige |>
  ggplot() +
  aes(y=prestige, x=type) +
  geom_boxplot()
```

```
# or
# library(plotly)
# p <- Prestige |> ggplot() +
#   aes(y=prestige, x=type) + geom_boxplot()
# ggplotly(p)

# or
# library(lattice)
# bwplot(prestige ~ type, data=Prestige)

# as violin plots
Prestige |>
  ggplot() +
  aes(y=prestige, x=type) +
  geom_violin()
```

```
# Or put it all together
Prestige |>
  ggplot() +
  aes(y=prestige, x=type) +
  geom_violin() +
  geom_boxplot(col = 2, alpha = .2) +
  geom_jitter(alpha = .2, width = .2, height = 0, colour = 4)
```

Exercise 2.5

Obtain the Empirical Cumulative Distribution Function (ECDF) graphs of `prestige ~ type`:

```
Prestige |>
  ggplot() +
  aes(prestige, colour=type) +
  stat_ecdf()
```

```
Prestige |>
  ggplot() +
  aes(prestige) +
  stat_ecdf() +
  facet_wrap(~type)
```

```
Prestige |>
  ggplot() +
  aes(
    x = prestige, # these aes settings are used
    col = type    # by both geoms
    ) +
  geom_density(
    aes(fill = type), # the 'fill' aes goes here because
    alpha = .2        # geom_rug doesn't use 'fill'
    ) +
  geom_rug()
```

With which plot – the ECDF or the density plot – is it easier to compare the distributions of prestige scores among these groups?

Exercise 2.6

Obtain the $\{0.05, 0.1, 0.25, 0.5, 0.75, 0.9, 0.95\}$ quantiles of `prestige`:

```r
pr <- c(0.01, 0.05, 0.1, 0.25, 0.5, 0.75, 0.9, 0.95, 0.99)

Prestige |>
  summarise(
    probs = pr,
    quants = quantile(prestige, pr)
    )

# or simply
quantile(Prestige$prestige, pr)
```

Exercise 2.7

Obtain the scatter plot (with and without marginal boxplots) **prestige vs. education** : How can you describe the relationship implied by the pattern?

```r
library(ggExtra)

p1 <- Prestige |>
  ggplot() +
  aes(x = education, y = prestige) +
  geom_point() +
  geom_smooth(col = 2) +
  geom_smooth(method = "lm", se = FALSE)

ggMarginal(p1, type="boxplot")
```

```r
library(car)

scatterplot(education ~ prestige, data = Prestige)
```

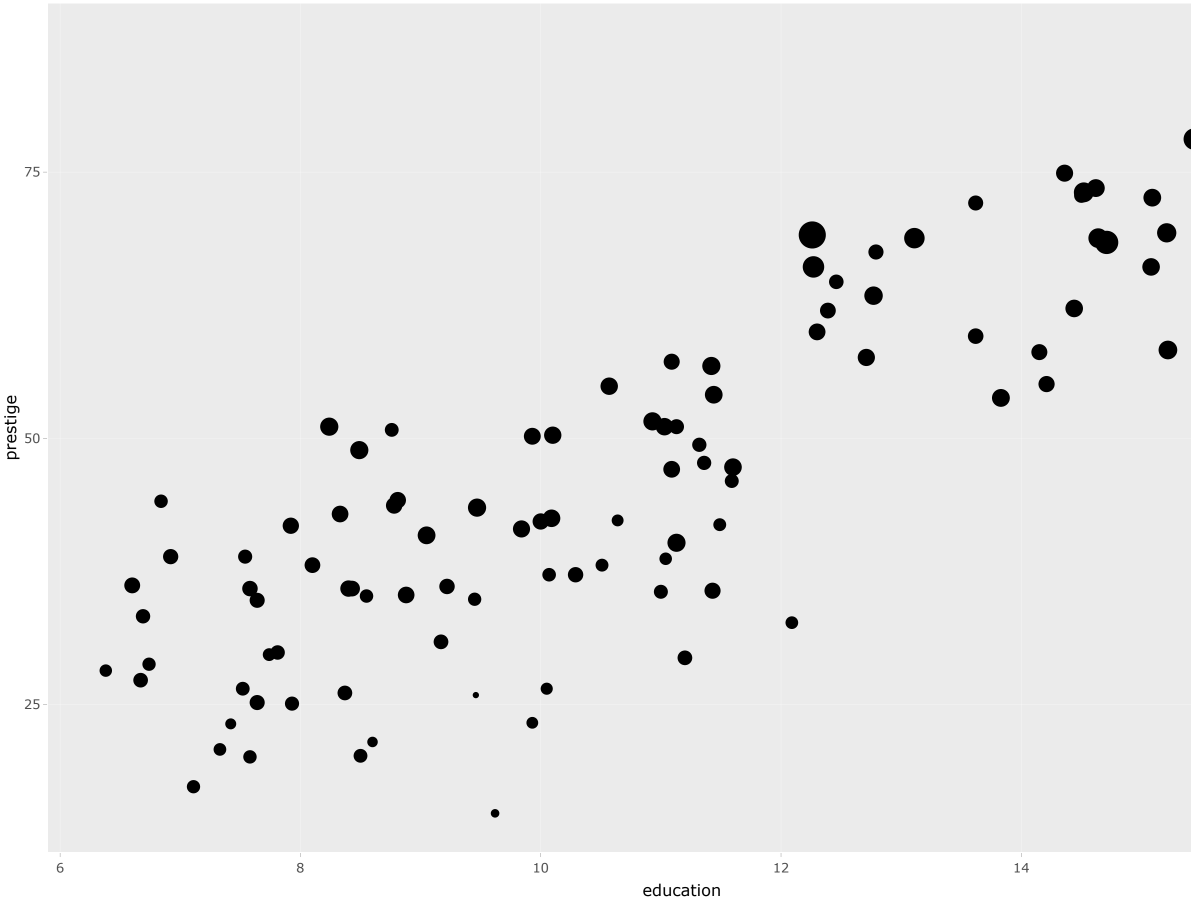
The later plot will show prediction interval ribbon while the first plot will show the confidence interval ribbon.

Exercise 2.8

Obtain the bubble or balloon plot **prestige vs. education vs. income** (income forming the bubble size):

```r
library(ggplot2)

Prestige |>
  ggplot() +
  aes(x = education, y = prestige, size = income) +
  geom_point()
```

```r
# or

library(plotly)

p <- Prestige |>
  ggplot() +
  aes(x = education, y = prestige, size = income) +
  geom_point()

ggplotly(p)
```

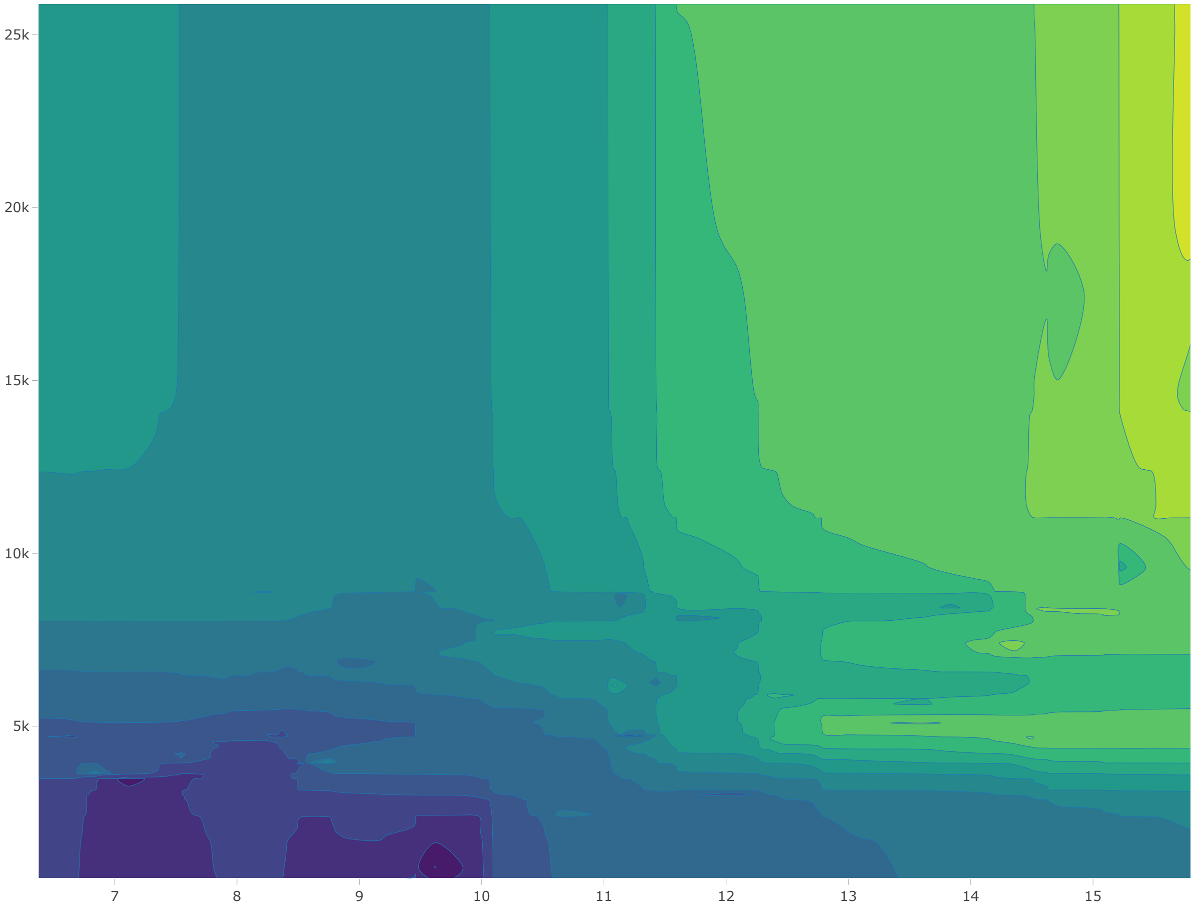


Make a different scatter plot using the same three variables. Keep `x = education, y = prestige` but use a different option to illustrate the influence of income.

Exercise 2.9

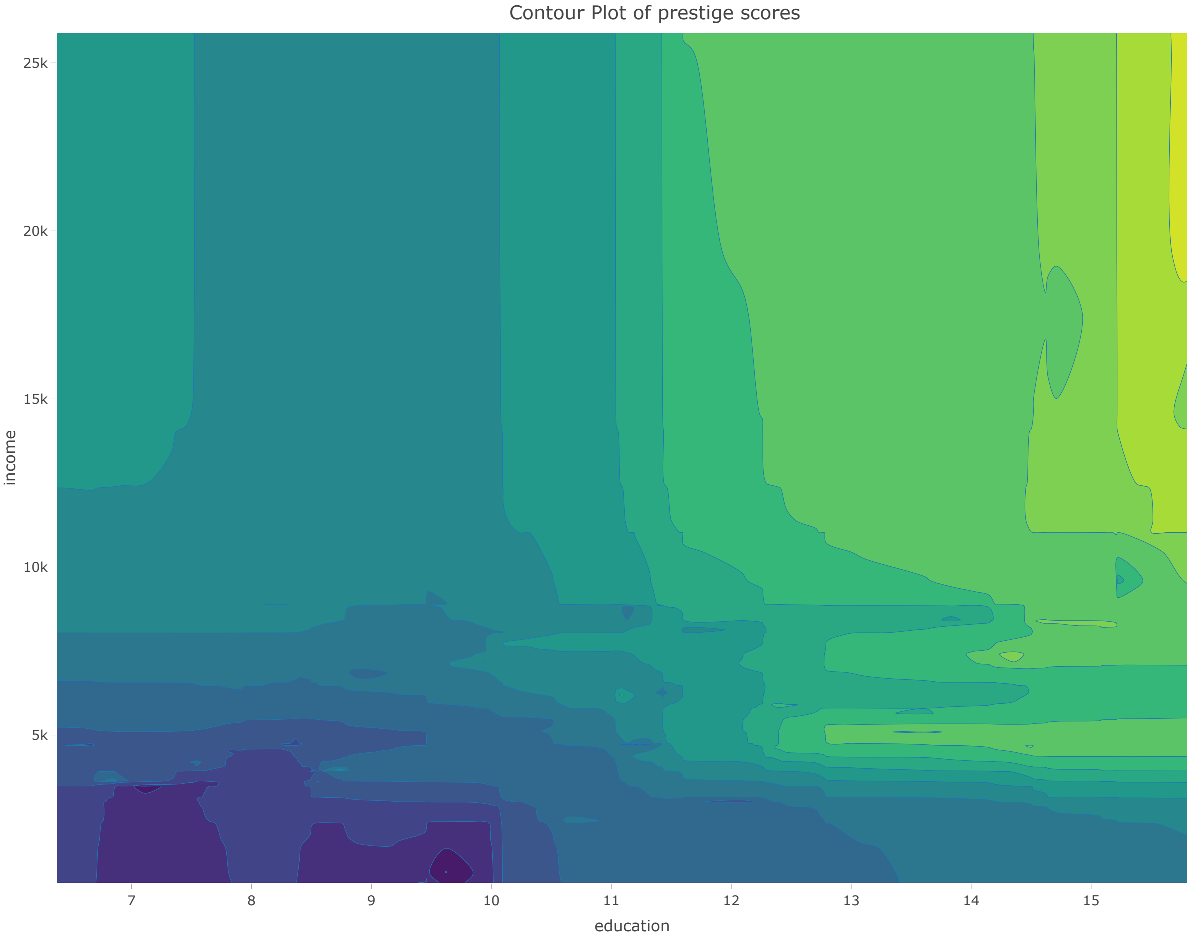
Obtain the contour plot **prestige vs. education vs. income** :

```
library(plotly)

plot_ly(type = 'contour',
        x = Prestige$education,
        y = Prestige$income,
        z = Prestige$prestige)
```



To add axes labels and titles, try-

```
plot_ly(
  Prestige,
  type = 'contour',
  x = Prestige$education,
  y = Prestige$income,
  z = Prestige$prestige
) |> layout(
  title = 'Contour Plot of prestige scores',
  xaxis = list(title = 'education'),
  yaxis = list(title = 'income')
)
```



Exercise 2.10

Create `prestige ~ education | type` graphs. That is, `prestige ~ education` grouped by `type` as colours and/or panels.

```
Prestige |>
  ggplot() +
  aes(x = education, y = prestige, colour = type) +
  geom_point() +
  facet_wrap(~ type)
```

```
# or
# library(plotly)
#
# p <- Prestige |>
#   ggplot() +
#   aes(x = education, y = prestige, color = type) +
#   geom_point() +
#   facet_wrap(~ type)
#
# ggplotly(p)
```

```
p <- Prestige |>
  ggplot() +
  aes(x = education, y = prestige, color = type) +
  geom_point()

p
```

```
# OR
#
# library(plotly)
# ggplotly(p)
```

Make it fancy

Adjusting labels

```
?labs()
```

color pallets

themes

More graphing examples are here (R code file).