Homework with **rmarkdown** and **knitr**

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This document assumes you are using the Rstudio IDE. The best way to obtain this document and examine all the files associated with the project is to:

1. Fork this repository to your own GitHub account.
2. Clone the forked repository into a local RStudio project.

To clone the repository, you will need a recent version of Git installed on your machine. This video shows how to clone a repository using the RStudio IDE. Several features from Pandoc (MacFarlane 2015), **rmarkdown** (Allaire et al. 2015), and **knitr** (Xie 2015) are illustrated in the document including numerous **knitr** chunk options (both local and global) which are fully documented online. Rstudio has a great "cheat sheet" for writing R markdown documents. Further information about R markdown can be found online. This document shows `R` code in the answers only when specifically directed in the question; however, all `R` code used in the document is visible in an **R-Code Appendix**. The YAML for this document is written as:

```
---
title: "Homework with **rmarkdown** and **knitr**"
author: "Alan T. Arnholt"
date: '2015-07-26'
output: html_document
bibliography:
- References/PackagesUsed.bib
- References/Main.bib
---
```

To add a bibliography to your document, you will need to create one or more `*.bib` files and add the YAML entry `bibliography: PathTo/file.bib` or use a list as above for multiple `*.bib` files. The **knitr** function `write_bib()` (Xie 2015) is used to create *automagically* a `*.bib` file of the `R` packages used in this document and store the file in `./References/PackagesUsed.bib` (See the **R-Code Appendix**). The two entries in `./References/Main.bib` were created by hand. The citation management system Zotero can create `BibTeX` files. This 4 minute video illustrates how to store bibliographic information using Zotero, and the following 2 minute video shows how to export the bibliographic information from Zotero to a `BibTeX` file. Inline `LaTeX` equations and display equations are placed between single and double `$` symbols, respectively. To learn more about `LaTeX`, see online resources such as https://en.wikibooks.org/wiki/LaTeX. If you need help with how to write a symbol in `LaTeX`, you can draw the symbol at this site; and `LaTeX` code corresponding to the user drawn symbol will appear.

Notes:

1. The RStudio IDE will populate most entries for the YAML; however, you will need manually to add the `bibliography` entry.
2. To create a PDF document (you must have LaTeX installed) or a Word document, change the YAML entry `output: html_document` to `output: pdf_document` or `output: word_document`, respectively.
3. To define the styles in a Word document generated from R markdown see this video.

Code chunks

1. The first code chunk named `setup` has local options `echo = FALSE`, `results= 'hide'`, `message = FALSE`, and `warning = FALSE`. These options have the chunk execute without echoing the code, displaying any results, messages, or warnings in the console. The global options for the document are defined with `knitr::opts_chunk$set()` (shown below). After the global options are defined, a character vector (`PackagesUsed`) is created with the names of the packages used in this document. The bibliographic information for the packages is automatically written to a file with the `write_bib()` function. Last, the packages are loaded and attached. If your installation does not have any of the packages referenced in `PackagesUsed`, you should install the missing packages using the function `install.packages()`.

```
knitr::opts_chunk$set(fig.show = 'as.is', fig.height = 6,
                      fig.width = 6, prompt = FALSE, highlight = TRUE,
                      tidy = FALSE, warning = FALSE, message = FALSE,
                      echo = FALSE, tidy.opts=list(blank = TRUE, width.cutoff= 65))
# Lists of R packages used
PackagesUsed <- c("PASWR2", "ggplot2", "knitr", "MASS", "DT", "lattice", "rmarkdown")
# Write bib information
knitr::write_bib(PackagesUsed, file = "./References/PackagesUsed.bib")
# Load packages
lapply(PackagesUsed, library, character.only = TRUE)
```

2. The second code chunk named `load` uses the local options `echo = TRUE`, `comment = NA`, and `prompt = TRUE`. The `echo = TRUE` overwrites the global option `echo = FALSE` and echoes all `R` code and output to the console. The option `comment = NA` removes the default comment (`##`), and the option `prompt = TRUE` displays the `R` prompt symbol (`>`).

3. The third code chunk named `partA` changes the height and width of the plot used in the graphics device from the global settings of 5 and 5, to 12 and 12 with the options `fig.height = 12`, and `fig.width = 12`.

4. The fourth code chunk named `partB` changes the height and width of the plot used in the graphics device from the global settings of 5 and 5, to 12 and 12 with the options `fig.height = 12`, and `fig.width = 12`.

5. The fifth code chunk named `partC` does not overwrite any of the global option setting.

6. The sixth code chunk named `partD` does not overwrite any of the global options.

7. The seventh code chunk named `partE` hides output send to the console with the local option `results = "hide"`.

8. The eighth code chunk named `tablestuff` uses the default global options.

9. The ninth code chunk named `appendix` shows all of the code used for all code chunks without evaluating the code with the options `echo = TRUE`, `ref.label = all_labels()`, and `eval = FALSE`.

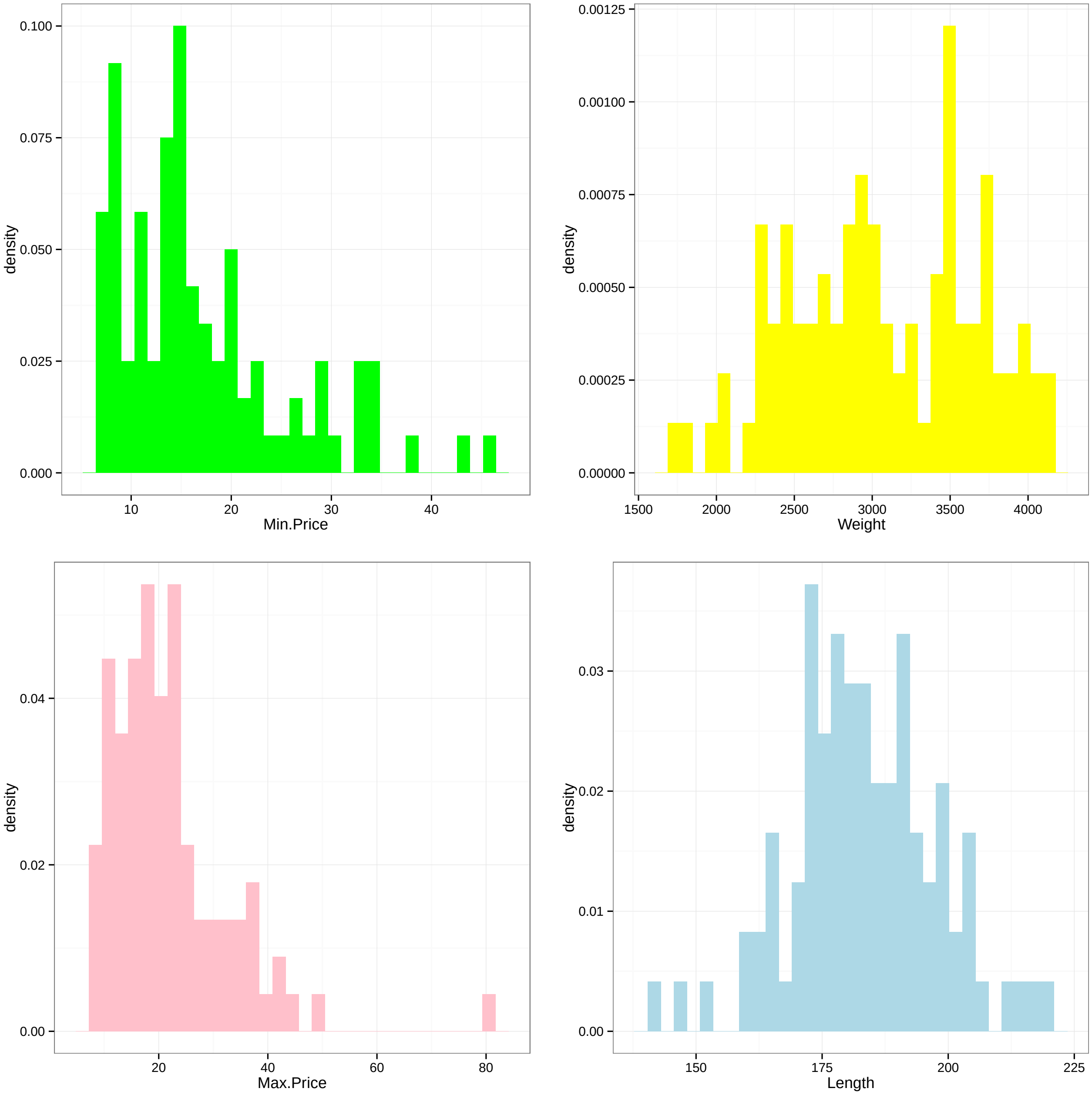
10. The tenth code chunk named `SessionInfo` uses the local option `echo = TRUE` to show the results of `sessionInfo()` in the console.

Modified question 2 from chapter 2 of (Ugarte, Militino, and Arnholt 2015) with brief answers. Load `Cars93` from the **MASS** package (Ripley 2015), and use the function `str()` on the `Cars93` data frame.

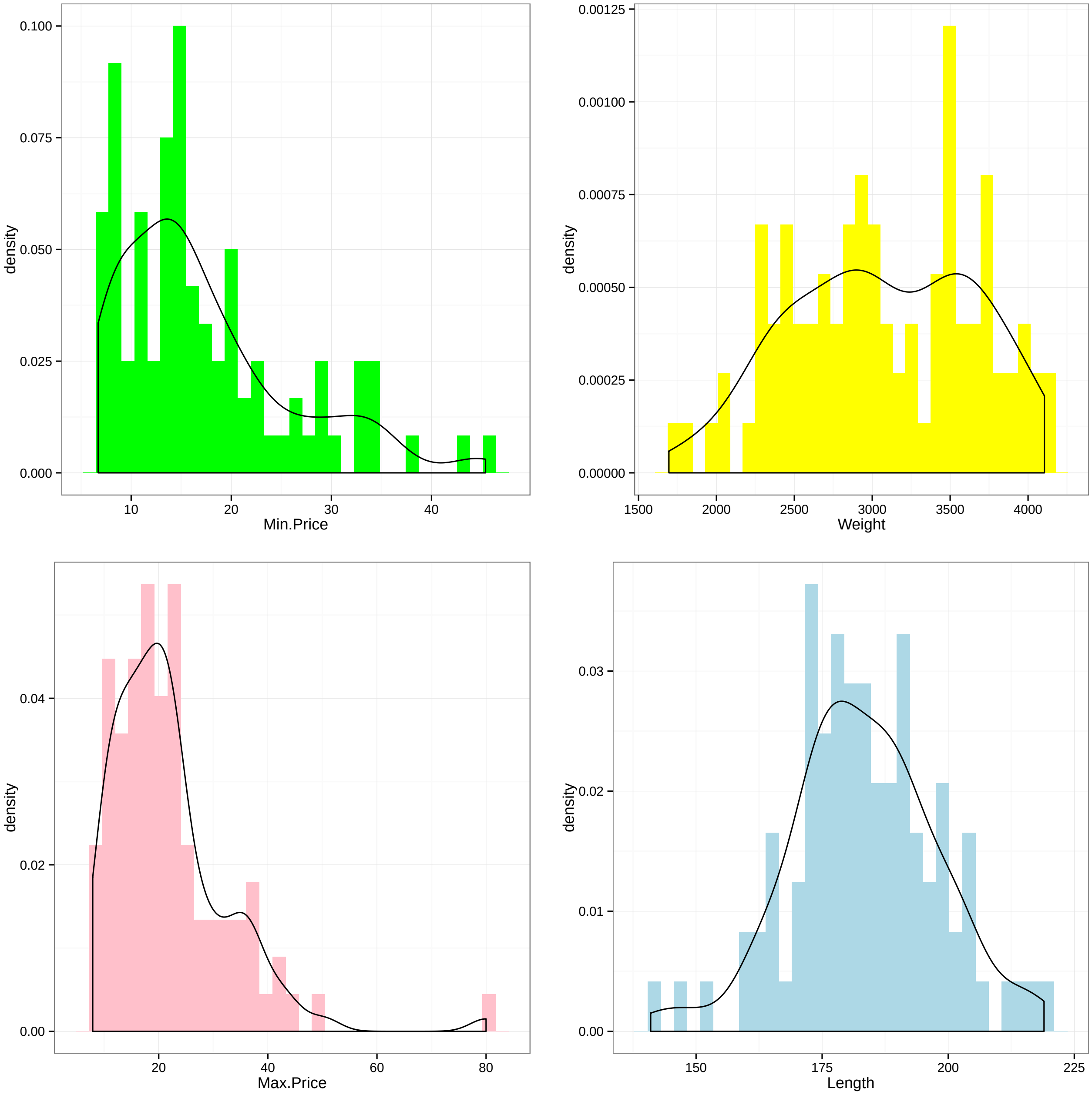
```
> library(MASS)
> str(Cars93)
```

```
'data.frame':   93 obs. of  27 variables:
 $ Manufacturer      : Factor w/ 32 levels "Acura","Audi",..: 1 1 2 2 3 4 4 4 4 5 ...
 $ Model             : Factor w/ 93 levels "100","190E","240",..: 49 56 9 1 6 24 54 74 73 35 ...
 $ Type              : Factor w/ 6 levels "Compact","Large",..: 4 3 1 3 3 3 2 2 3 2 ...
 $ Min.Price         : num  12.9 29.2 25.9 30.8 23.7 14.2 19.9 22.6 26.3 33 ...
 $ Price             : num  15.9 33.9 29.1 37.7 30 15.7 20.8 23.7 26.3 34.7 ...
 $ Max.Price         : num  18.8 38.7 32.3 44.6 36.2 17.3 21.7 24.9 26.3 36.3 ...
 $ MPG.city          : int  25 18 20 19 22 22 19 16 19 16 ...
 $ MPG.highway       : int  31 25 26 26 30 31 28 25 27 25 ...
 $ AirBags           : Factor w/ 3 levels "Driver & Passenger",..: 3 1 2 1 2 2 2 2 2 2 ...
 $ DriveTrain        : Factor w/ 3 levels "4WD","Front",..: 2 2 2 2 3 2 2 3 2 2 ...
 $ Cylinders         : Factor w/ 6 levels "3","4","5","6",..: 2 4 4 4 2 2 4 4 4 5 ...
 $ EngineSize        : num  1.8 3.2 2.8 2.8 3.5 2.2 3.8 5.7 3.8 4.9 ...
 $ Horsepower        : int  140 200 172 172 208 110 170 180 170 200 ...
 $ RPM               : int  6300 5500 5500 5500 5700 5200 4800 4000 4800 4100 ...
 $ Rev.per.mile      : int  2890 2335 2280 2535 2545 2565 1570 1320 1690 1510 ...
 $ Man.trans.avail   : Factor w/ 2 levels "No","Yes": 2 2 2 2 2 1 1 1 1 1 ...
 $ Fuel.tank.capacity: num  13.2 18 16.9 21.1 21.1 16.4 18 23 18.8 18 ...
 $ Passengers        : int  5 5 5 6 4 6 6 6 5 6 ...
 $ Length            : int  177 195 180 193 186 189 200 216 198 206 ...
 $ Wheelbase         : int  102 115 102 106 109 105 111 116 108 114 ...
 $ Width             : int  68 71 67 70 69 69 74 78 73 73 ...
 $ Turn.circle       : int  37 38 37 37 39 41 42 45 41 43 ...
 $ Rear.seat.room    : num  26.5 30 28 31 27 28 30.5 30.5 26.5 35 ...
 $ Luggage.room      : int  11 15 14 17 13 16 17 21 14 18 ...
 $ Weight            : int  2705 3560 3375 3405 3640 2880 3470 4105 3495 3620 ...
 $ Origin            : Factor w/ 2 levels "USA","non-USA": 2 2 2 2 2 1 1 1 1 1 ...
 $ Make              : Factor w/ 93 levels "Acura Integra",..: 1 2 4 3 5 6 7 9 8 10 ...
```

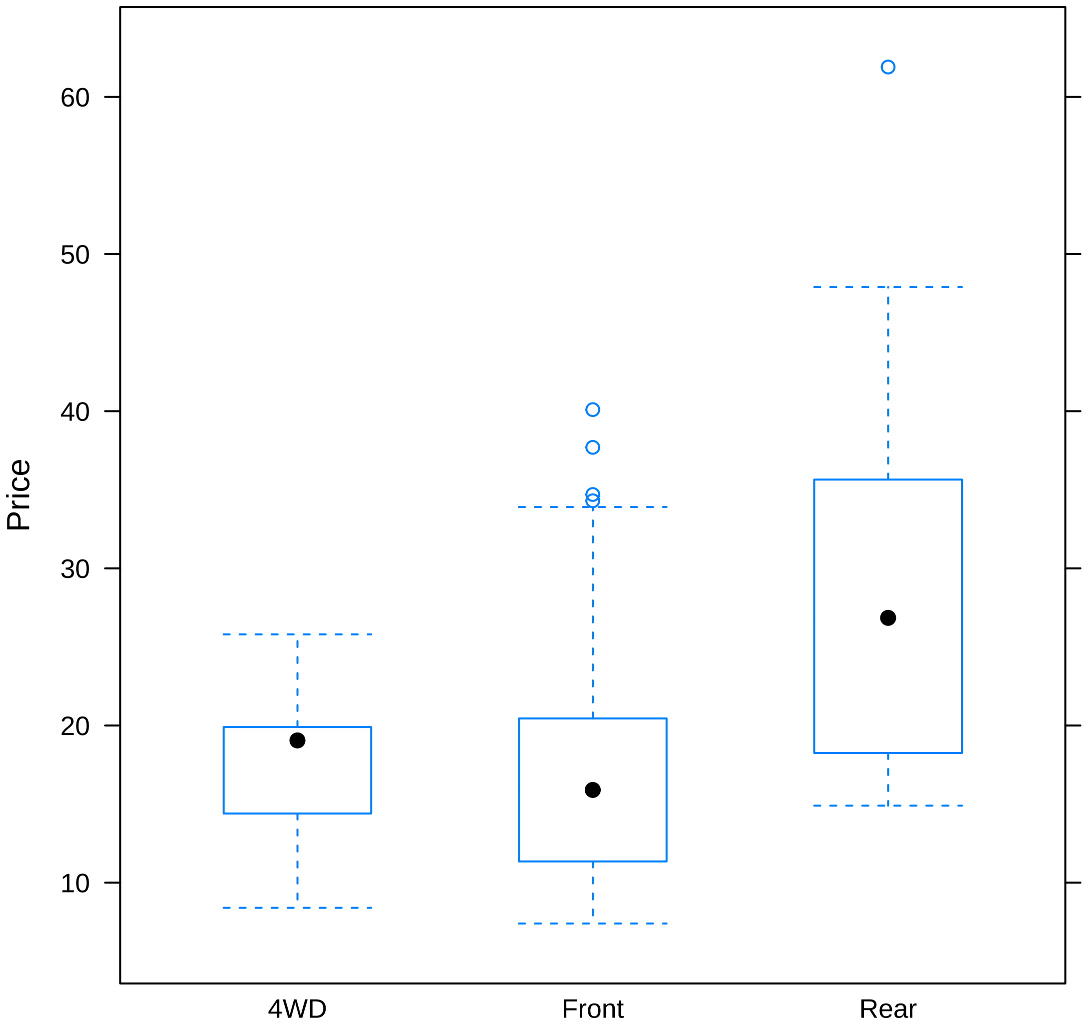
(a) Create density histograms for the variables `Min.Price`, `Max.Price`, `Weight`, and `Length` variables using a different color for each histogram.



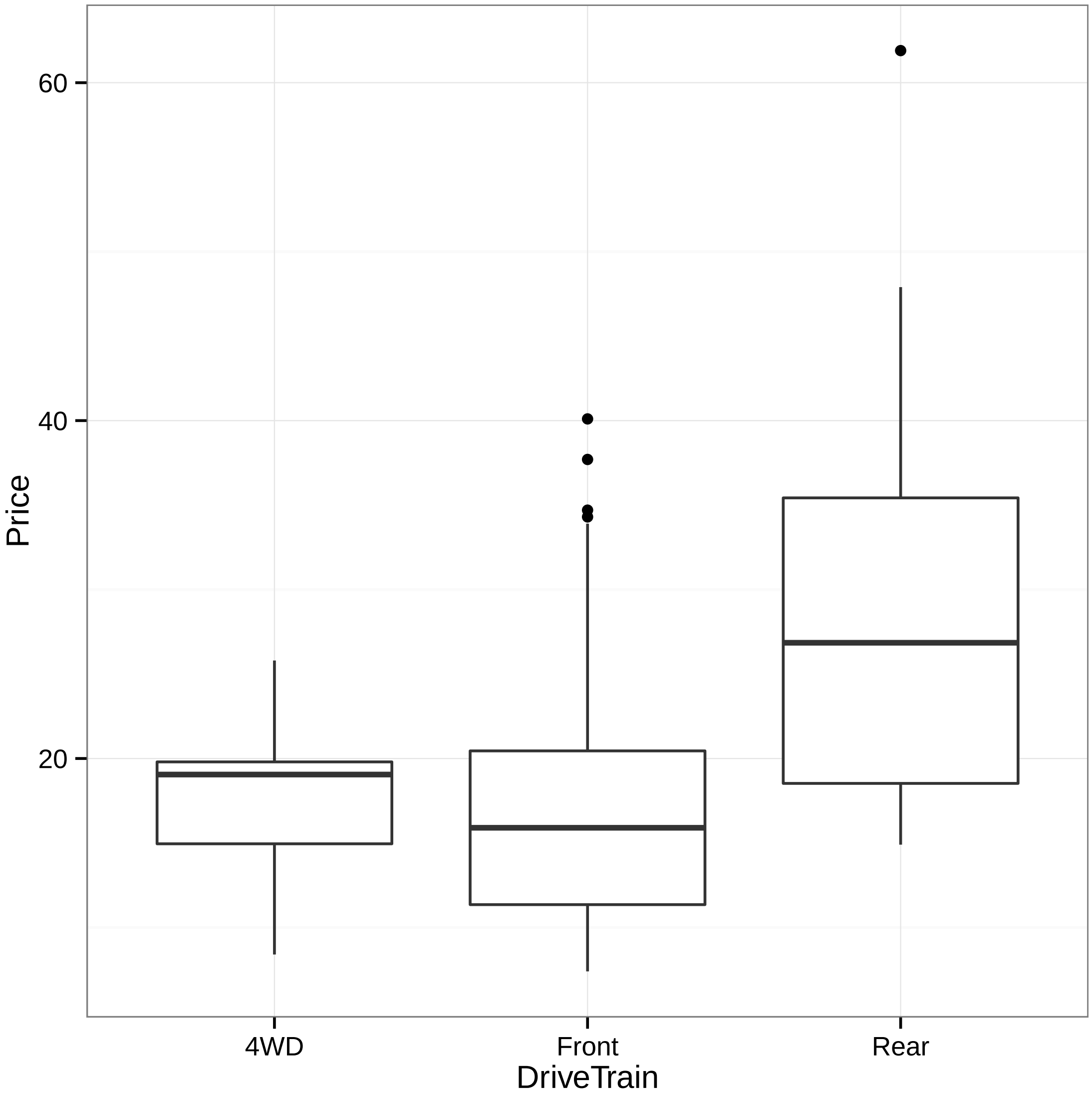
(b) Superimpose estimated density curves over the histograms.



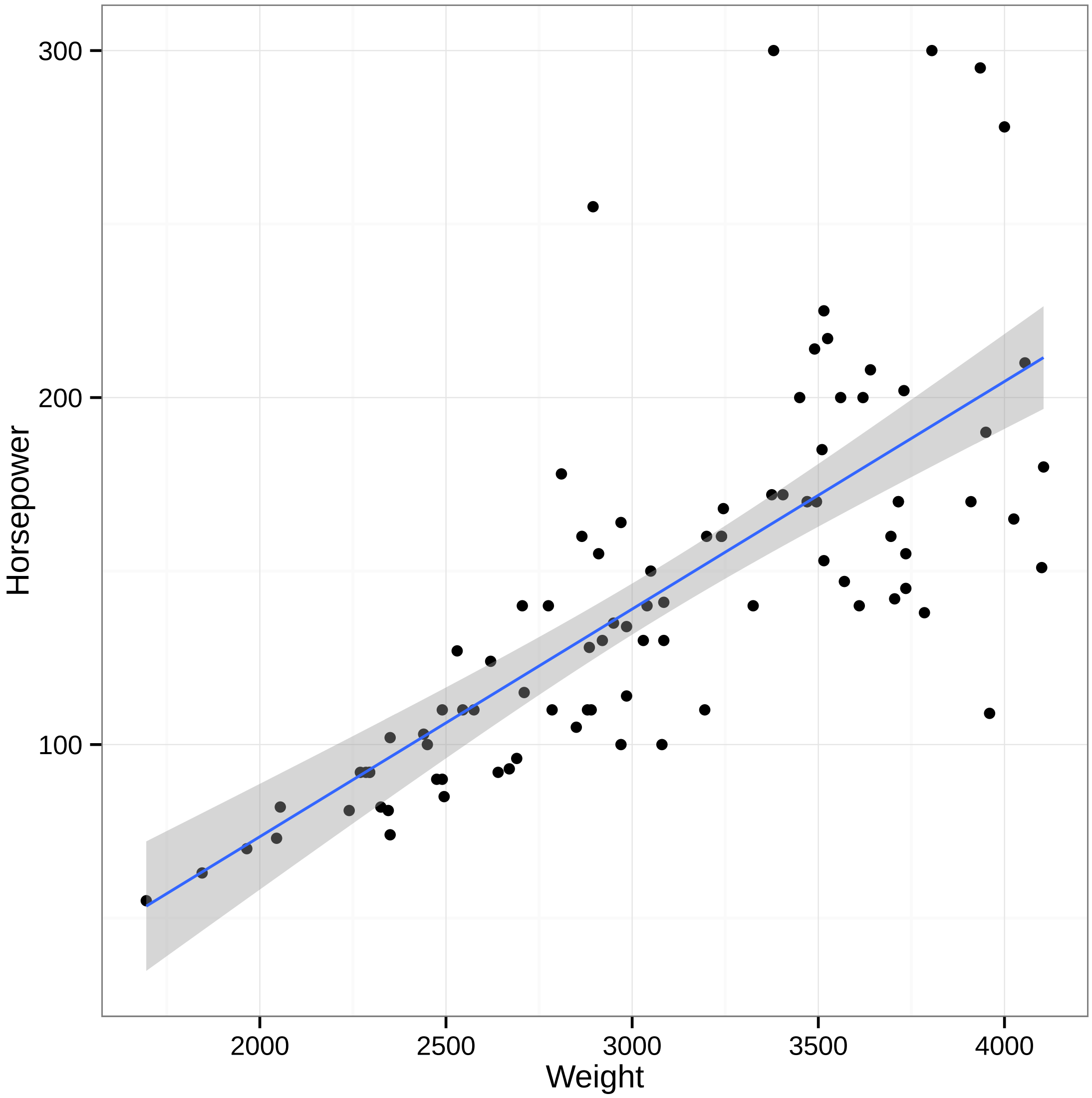
(c) Use the `bwplot()` function from **lattice** (Sarkar 2015) to create a box and whiskers plot of Price for every type of vehicle according to the drive train. Do you observe any differences between prices? *Rear wheel drive vehicles are generally more expensive than either 4WD or front wheel drive vehicles.*



(d) Create a graph similar to the one created in (c) using functions from **ggplot2** (Wickham and Chang 2015).



(e) Create scatter plot of `Horsepower` versus `Weight`, and superimpose the least squares line from regressing `Horsepower` onto `Weight`. Write out the least squares line and the theoretical least squares model.



The least squares line from regressing `Horsepower` onto `Weight` is: $\widehat{\text{Horsepower}} = -57.7382032 + 0.0655947 \times$ Weight. The theoretical model for least squares regression is: $Y = \beta_0 + \beta_1 x + \epsilon$ where $\epsilon \sim N(0, \sigma^2)$.

Use the data frame `EPIDURALF` from the **PASWR2** package (Arnholt 2014), and create a table of the average weight of parturient women classified by `ease` and `treatment`.

Table 1: Table: Mean weight (kg.) of parturient women classified by `ease` and `treatment`

	Hamstring Stretch	Traditional Sitting
Easy	78.67000	79.40187
Difficult	92.66667	94.27451
Impossible	127.87500	113.61538

R-Code Appendix

```
knitr::opts_chunk$set(fig.show = 'as.is', fig.height = 6,
                      fig.width = 6, prompt = FALSE, highlight = TRUE,
                      tidy = FALSE, warning = FALSE, message = FALSE,
                      echo = FALSE, tidy.opts=list(blank = TRUE, width.cutoff= 65))
# Lists of R packages used
PackagesUsed <- c("PASWR2", "ggplot2", "knitr", "MASS", "DT", "lattice", "rmarkdown")
# Write bib information
knitr::write_bib(PackagesUsed, file = "./References/PackagesUsed.bib")
# Load packages
lapply(PackagesUsed, library, character.only = TRUE)
library(MASS)
str(Cars93)
# Create graphs for part a
p1 <- ggplot(data = Cars93, aes(x = Min.Price, y = ..density..)) +
  geom_histogram(fill = "green") +
  theme_bw()
p2 <- ggplot(data = Cars93, aes(x = Max.Price, y = ..density..)) +
  geom_histogram(fill = "pink") +
  theme_bw()
p3 <- ggplot(data = Cars93, aes(x = Weight, y = ..density..)) +
  geom_histogram(fill = "yellow") +
  theme_bw()
p4 <- ggplot(data = Cars93, aes(x = Length, y = ..density..)) +
  geom_histogram(fill = "lightblue") +
  theme_bw()
multiplot(p1, p2, p3, p4, cols = 2)
# Create graphs for part b
p1 <- ggplot(data = Cars93, aes(x = Min.Price, y = ..density..)) +
  geom_histogram(fill = "green") +
  theme_bw() +
  geom_density()
p2 <- ggplot(data = Cars93, aes(x = Max.Price, y = ..density..)) +
  geom_histogram(fill = "pink") +
  theme_bw() +
  geom_density()
p3 <- ggplot(data = Cars93, aes(x = Weight, y = ..density..)) +
  geom_histogram(fill = "yellow") +
  theme_bw() +
  geom_density()
p4 <- ggplot(data = Cars93, aes(x = Length, y = ..density..)) +
  geom_histogram(fill = "lightblue") +
  theme_bw() +
  geom_density()
multiplot(p1, p2, p3, p4, cols = 2)
# Graph for part c
bwplot(Price ~ DriveTrain, data = Cars93)
# Graph for part d
ggplot(data = Cars93, aes(x = DriveTrain, y = Price)) +
  geom_boxplot() +
  theme_bw()
# Graph for part e
```

```
ggplot(data = Cars93, aes(x = Weight, y = Horsepower)) +
  geom_point() +
  stat_smooth(method = "lm") +
  theme_bw()
mod_lm <- lm(Horsepower ~ Weight, data = Cars93)
summary(mod_lm)
# Create requested table with kable
# levels in order of difficulty
EPIDURALF$ease <- factor(EPIDURALF$ease, levels = c("Easy", "Difficult", "Impossible"))
TS <- with(data = EPIDURALF, {tapply(kg, list(ease, treatment), mean)})
DF <- data.frame(TS)
knitr::kable(DF, col.names = c("Hamstring Stretch", "Traditional Sitting"),
             caption = "Table: Mean weight (kg.) of parturient women
             classified by `ease` and `treatment`")
sessionInfo()
```

It is always a good idea to include your `sessionInfo()`:

```
sessionInfo()
```

```
## R version 3.2.1 (2015-06-18)
## Platform: x86_64-apple-darwin13.4.0 (64-bit)
## Running under: OS X 10.10.4 (Yosemite)
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] rmarkdown_0.7   DT_0.1          MASS_7.3-43     knitr_1.10.5
## [5] PASWR2_1.0      lattice_0.20-33 ggplot2_1.0.1
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.0      magrittr_1.5     munsell_0.4.2    colorspace_1.2-6
##  [5] highr_0.5        stringr_1.0.0    plyr_1.8.3       tools_3.2.1
##  [9] grid_3.2.1       gtable_0.1.2     e1071_1.6-6      htmltools_0.2.6
## [13] class_7.3-13     yaml_2.1.13      digest_0.6.8     reshape2_1.4.1
## [17] formatR_1.2      htmlwidgets_0.5  evaluate_0.7     labeling_0.3
## [21] stringi_0.5-5    scales_0.2.5     proto_0.3-10
```

References

Allaire, JJ, Joe Cheng, Yihui Xie, Jonathan McPherson, Winston Chang, Jeff Allen, Hadley Wickham, and Rob Hyndman. 2015. *Rmarkdown: Dynamic Documents for R*. http://CRAN.R-project.org/package=rmarkdown.

Arnholt, Alan T. 2014. *PASWR2: Probability and Statistics with R, Second Edition*. http://CRAN.R-project.org/package=PASWR2.

MacFarlane, John. 2015. *Pandoc: A Universal Document Converter*. http://johnmacfarlane.net/pandoc/index.html.

Ripley, Brian. 2015. *MASS: Support Functions and Datasets for Venables and Ripley's MASS*. http://CRAN.R-project.org/package=MASS.

Sarkar, Deepayan. 2015. *Lattice: Trellis Graphics for R*. http://CRAN.R-project.org/package=lattice.

Ugarte, María Dolores, Ana F. Militino, and Alan T. Arnholt. 2015. *Probability and Statistics with R*. Second. Boca Raton, FL: CRC Press.

Wickham, Hadley, and Winston Chang. 2015. *Ggplot2: An Implementation of the Grammar of Graphics*. http://CRAN.R-project.org/package=ggplot2.

Xie, Yihui. 2015. *Knitr: A General-Purpose Package for Dynamic Report Generation in R*. http://CRAN.R-project.org/package=knitr.