SDM4 in R: The Standard Deviation as a Ruler and the Normal Model (Chapter 5)

Nicholas Horton (nhorton@amherst.edu)

August 12, 2017

Introduction and background

This document is intended to help describe how to undertake analyses introduced as examples in the Fourth Edition of *Stats: Data and Models* (2014) by De Veaux, Velleman, and Bock. More information about the book can be found at http://wps.aw.com/aw_deveaux_stats_series. This file as well as the associated R Markdown reproducible analysis source file used to create it can be found at http://nhorton.people.amherst.edu/sdm4.

This work leverages initiatives undertaken by Project MOSAIC (http://www.mosaic-web.org), an NSF-funded effort to improve the teaching of statistics, calculus, science and computing in the undergraduate curriculum. In particular, we utilize the `mosaic` package, which was written to simplify the use of R for introductory statistics courses. A short summary of the R needed to teach introductory statistics can be found in the mosaic package vignettes (http://cran.r-project.org/web/packages/mosaic). A paper describing the mosaic approach was published in the *R Journal*: https://journal.r-project.org/archive/2017/RJ-2017-024.

Chapter 5: The standard deviation as a ruler and the normal model

Section 5.1: Standardizing with z-scores

```
library(mosaic); library(readr)
options(na.rm=TRUE)
options(digits=3)
(6.54 - 5.91)/0.56  # should be 1.1 sd better, see page 112
```

```
## [1] 1.12
```

```
Heptathlon <-
read_delim("http://nhorton.people.amherst.edu/sdm4/data/Womens_Heptathlon_2012.txt",
  delim="\t")
nrow(Heptathlon)
```

```
## [1] 38
```

```
filter(Heptathlon, LJ >= max(LJ, na.rm=TRUE)) %>% data.frame()
```

```
##   Rank                                Athlete Total_Points
## 1    3 Chernova, TatyanaTatyana Chernova (RUS)         6628
##   X100_m_hurdle_points X100_m_hurdles HJ_Points HJ. SP_Points   SP
## 1                 1053           13.5       978 1.8       805 14.2
##   X200.m_Points X200_m LJ_Points   LJ JT_Points   JT X800_m_Points X800_m
## 1          1013   23.7      1020 6.54       788 46.5           971    130
```

```r
favstats(~ LJ, data=Heptathlon)
```

```
##  min   Q1 median   Q3  max mean    sd  n missing
##  3.7 5.83   6.01 6.19 6.54 5.91 0.564 35       3
```

```r
(6.54 - mean(~ LJ, data=Heptathlon))/sd(~ LJ, data=Heptathlon)
```

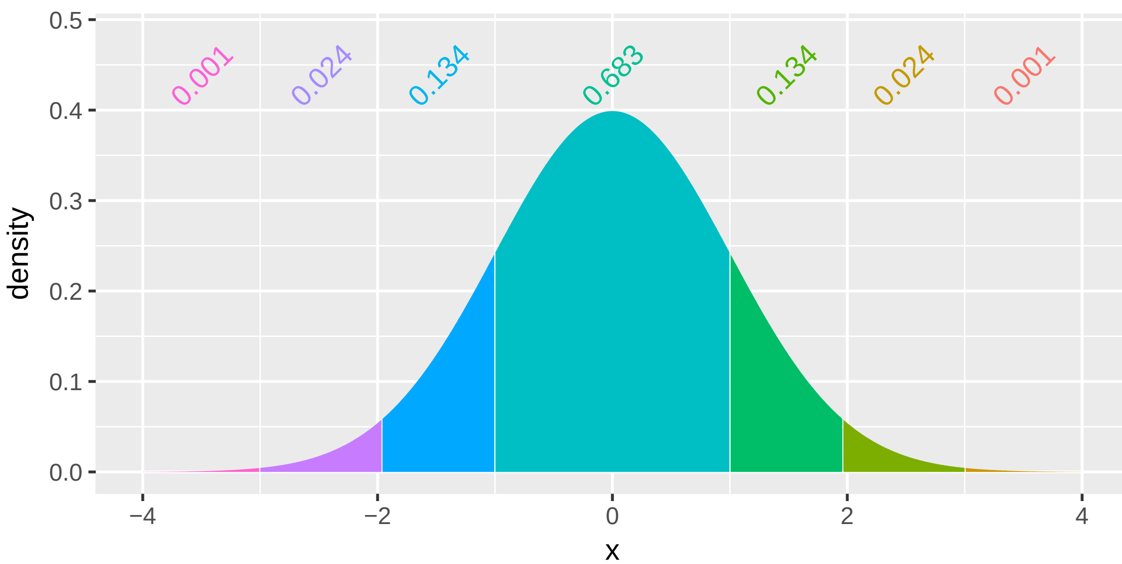
```
## [1] 1.11
```

Section 5.2: Shifting and scaling

Section 5.3: Normal models

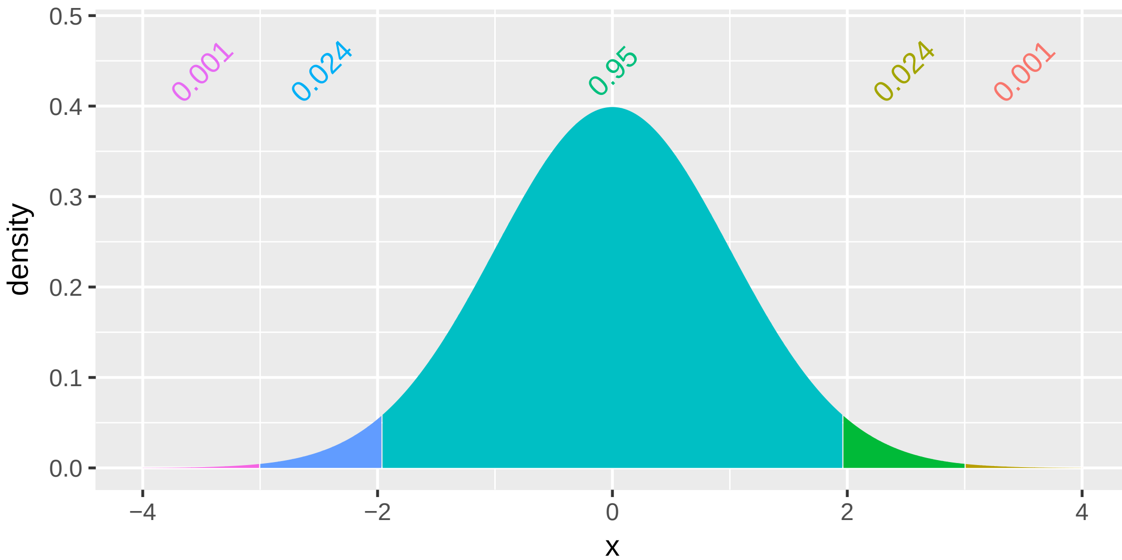
The 68-95-99.7 rule

```r
xpnorm(c(-3, -1.96, -1, 1, 1.96, 3), mean=0, sd=1, verbose=FALSE)
```



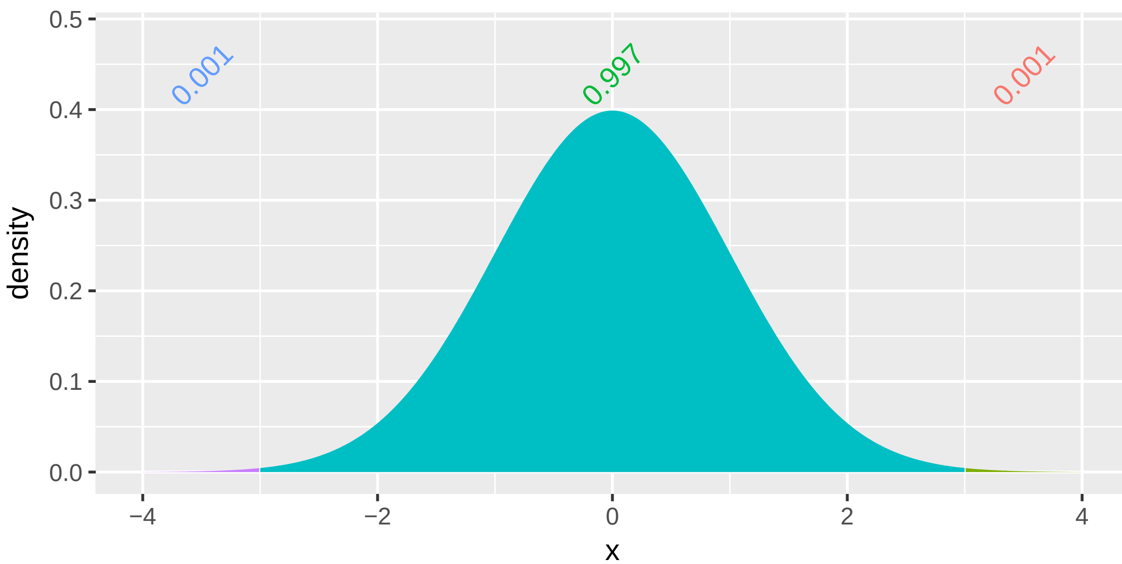

```
## [1] 0.00135 0.02500 0.15866 0.84134 0.97500 0.99865
```

```r
xpnorm(c(-3, -1.96, 1.96, 3), mean=0, sd=1, verbose=FALSE)
```




```
## [1] 0.00135 0.02500 0.97500 0.99865
```

```r
xpnorm(c(-3, 3), mean=0, sd=1, verbose=FALSE)
```




```
## [1] 0.00135 0.99865
```

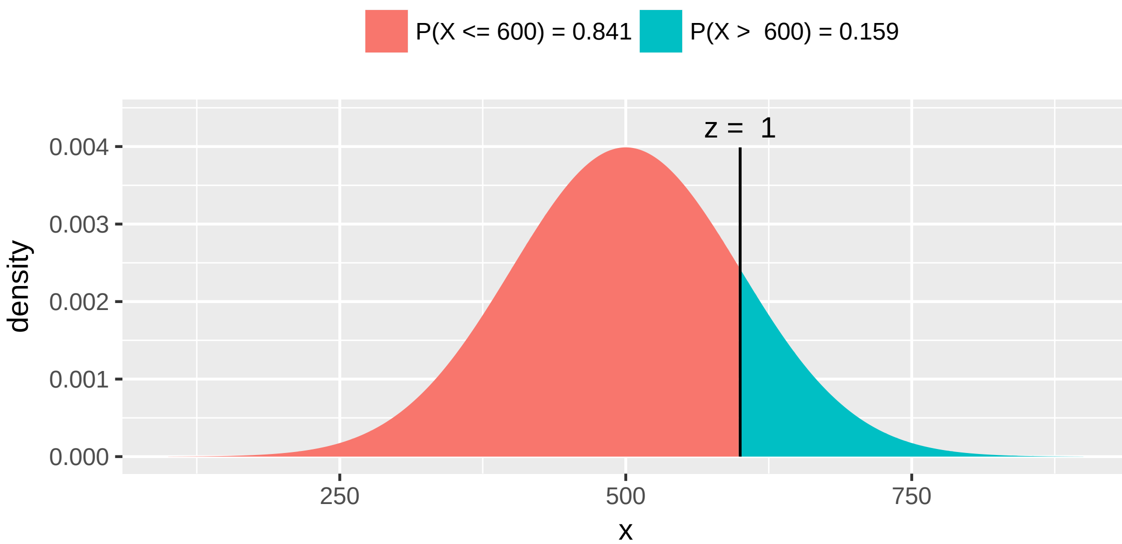
Step-by-step (page 122)

```r
xpnorm(600, mean=500, sd=100)
```

```
##
## If X ~ N(500, 100), then
##  P(X <= 600) = P(Z <= 1) = 0.8413
```

```
##  P(X >  600) = P(Z >  1) = 0.1587

##
```




```
## [1] 0.841
```

Section 5.4: Finding normal percentiles

as on page 123

```
xpnorm(680, mean=500, sd=100)
```

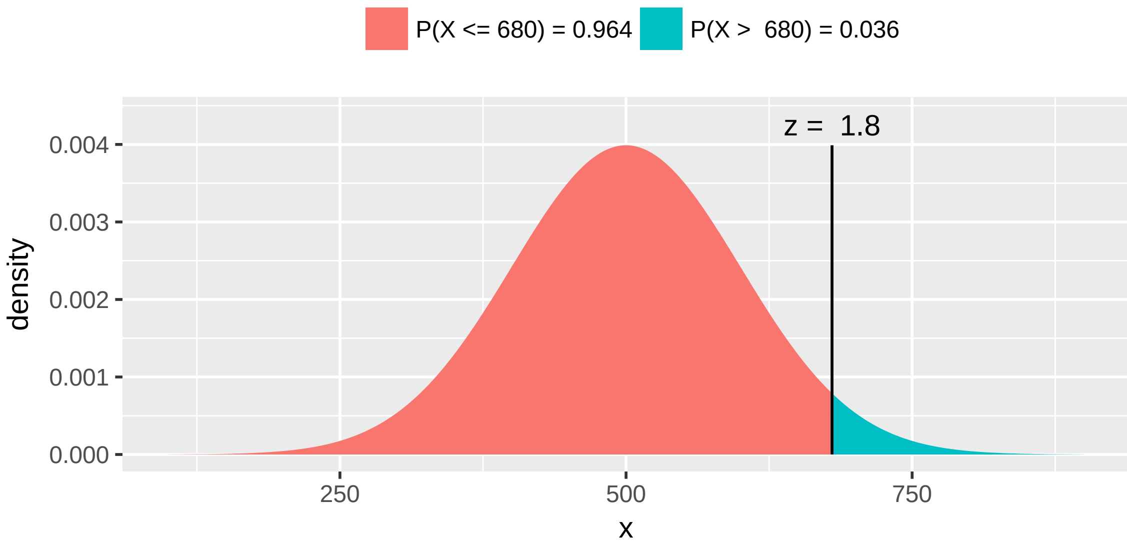
```
##

## If X ~ N(500, 100), then

##  P(X <= 680) = P(Z <= 1.8) = 0.9641

##  P(X >  680) = P(Z >  1.8) = 0.03593

##
```




```
## [1] 0.964
```

```r
qnorm(0.964, mean=500, sd=100)    # inverse of pnorm()
```

```
## [1] 680
```

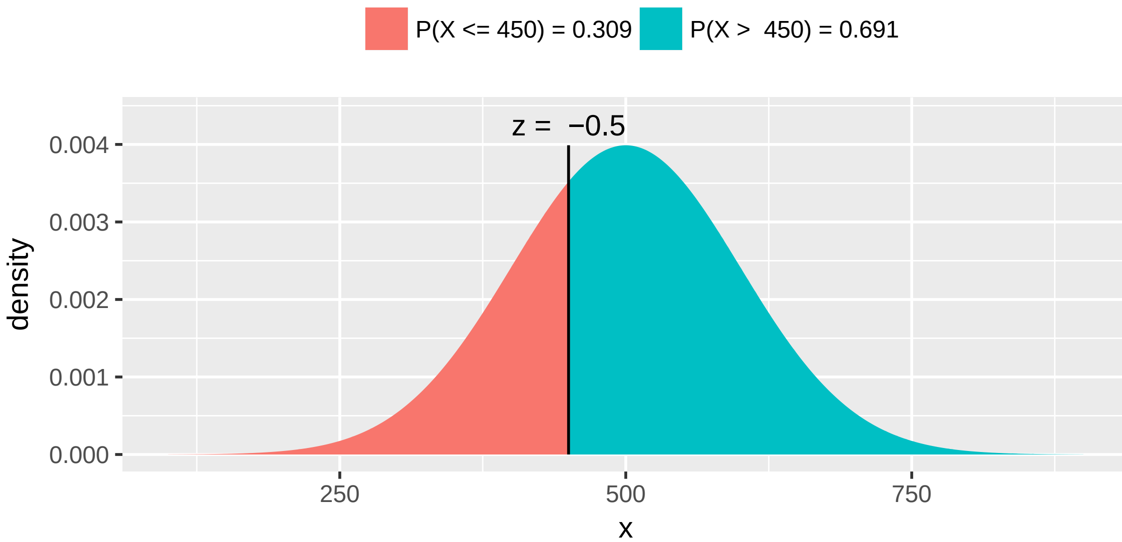
```r
qnorm(0.964, mean=0, sd=1)    # what is the z-score?
```

```
## [1] 1.8
```

or on page 124

```r
xpnorm(450, mean=500, sd=100)
```

```
##
## If X ~ N(500, 100), then
##  P(X <= 450) = P(Z <= -0.5) = 0.3085
##  P(X >  450) = P(Z >  -0.5) = 0.6915
##
```




```
## [1] 0.309
```

and page 125

```
qnorm(.9, mean=500, sd=100)
```

```
## [1] 628
```

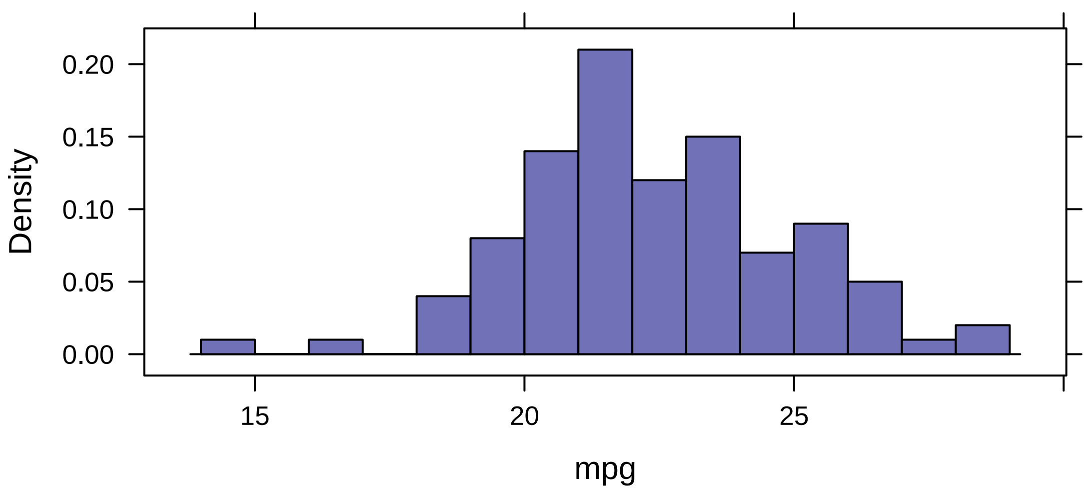
```
qnorm(.9, mean=0, sd=1)    # or as a Z-score
```

```
## [1] 1.28
```

Section 5.5: Normal probability plots

See Figure 5.8 on page 129

```
Nissan <-
read_delim("http://nhorton.people.amherst.edu/sdm4/data/Nissan.txt",
  delim="\t")
histogram(~ mpg, width=1, center=0.5, data=Nissan)
```



```r
qqmath(~ mpg, data=Nissan)
```