SDM4 in R: Comparing Counts (Chapter 24)

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June 28, 2018

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 24: Comparing Counts

Section 24.1: Goodness-of-fit tests

Here we verify the calculations of expected counts for ballplayers by month (page 656).

```
ballplayer <- c(137, 121, 116, 121, 126, 114,
                102, 165, 134, 115, 105, 122)
national <- c(0.08, 0.07, 0.08, 0.08, 0.08, 0.08,
              0.09, 0.09, 0.09, 0.09, 0.08, 0.09)
n <- sum(~ ballplayer)
n
```

```
## [1] 1478
```

```
sum(~ national)
```

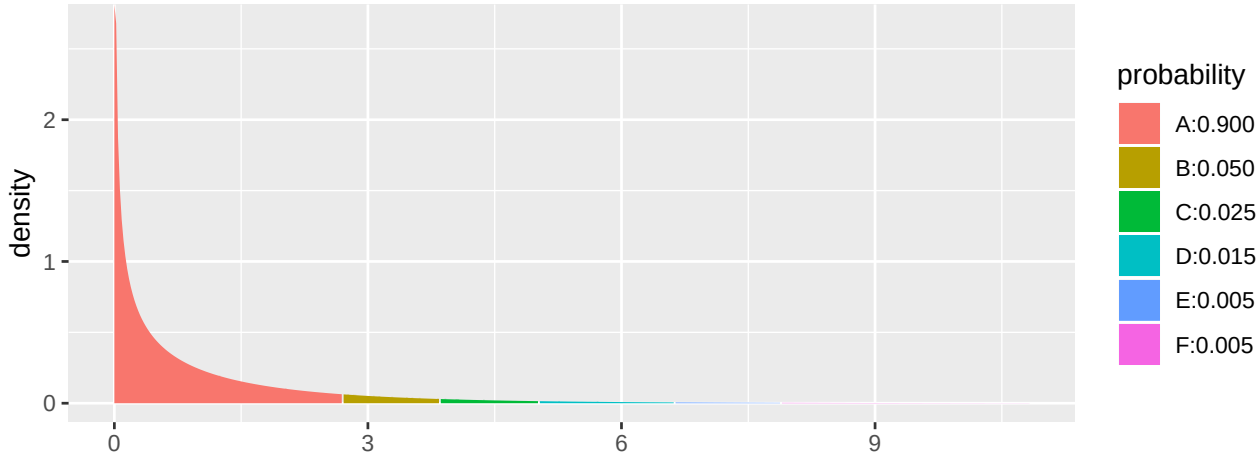
```
## [1] 1
```

```
expect <- n*national
cbind(ballplayer, expect)
```

```
##       ballplayer expect
##  [1,]        137 118.24
##  [2,]        121 103.46
##  [3,]        116 118.24
##  [4,]        121 118.24
##  [5,]        126 118.24
##  [6,]        114 118.24
##  [7,]        102 133.02
##  [8,]        165 133.02
##  [9,]        134 133.02
## [10,]        115 133.02
## [11,]        105 118.24
## [12,]        122 133.02
```

The chi-square quantile values in the table on the bottom of page 658 can be verified using the `xqt()` function.

```
xqchisq(c(.90, .95, .975, .99, .995), df = 1)
```




```
## [1] 2.7055 3.8415 5.0239 6.6349 7.8794
```

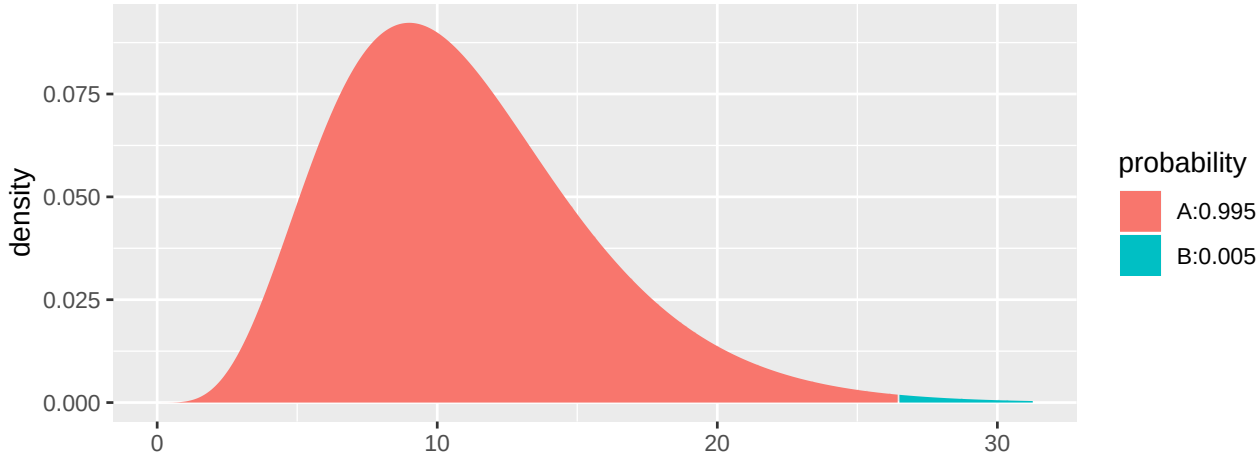
These results match the first row: other values can be calculated by changing the `df` argument.

The goodness of fit test on page 659 can be verified by calculating the chi-square statistic.

```
chisq <- sum((ballplayer - expect)^2/expect)
chisq
```

```
## [1] 26.484
```

```
1-xpchisq(chisq, df = 11)
```




```
## [1] 0.005494
```

Section 24.2: Chi-square test of homogeneity

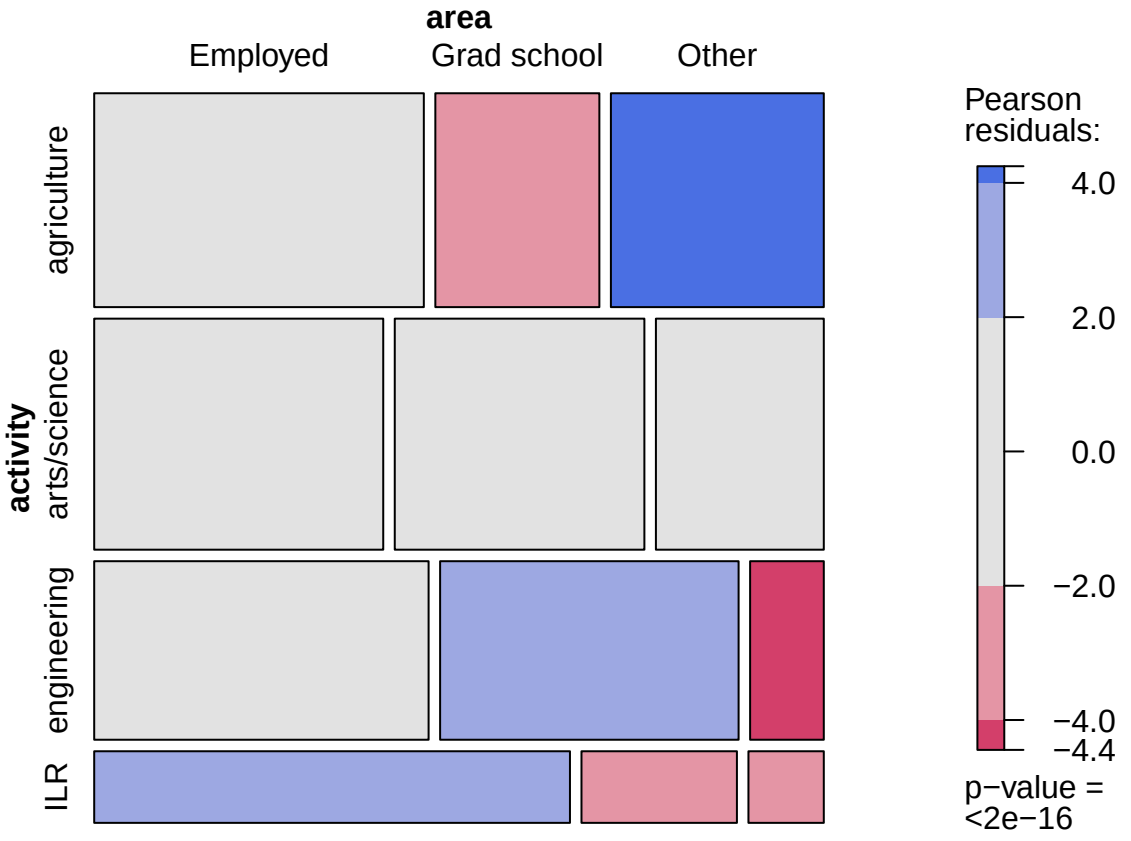
Data from one university regarding the association between postgraduation activity and area of study is displayed in Table 24.1 (page 663). The `do()` function can be used to generate each of the rows in the table.

```
schooldata <- rbind(
  do(209) * data.frame(activity = "agriculture",  area = "Employed"),
  do(198) * data.frame(activity = "arts/science", area = "Employed"),
```

```
  do(177) * data.frame(activity = "engineering",  area = "Employed"),
  do(101) * data.frame(activity = "ILR",          area = "Employed"),
  do(104) * data.frame(activity = "agriculture",  area = "Grad school"),
  do(171) * data.frame(activity = "arts/science", area = "Grad school"),
  do(158) * data.frame(activity = "engineering",  area = "Grad school"),
  do(33) *  data.frame(activity = "ILR",          area = "Grad school"),
  do(135) * data.frame(activity = "agriculture",  area = "Other"),
  do(115) * data.frame(activity = "arts/science", area = "Other"),
  do(39) *  data.frame(activity = "engineering",  area = "Other"),
  do(16) *  data.frame(activity = "ILR",          area = "Other")
)
tally(~ area + activity, margins = TRUE, data = schooldata)
```

```
##              activity
## area          agriculture arts/science engineering  ILR Total
##   Employed            209           198         177  101   685
##   Grad school         104           171         158   33   466
##   Other               135           115          39   16   305
##   Total               448           484         374  150  1456
```

```
vcd::mosaic(tally(~ activity + area, data = schooldata),
  main = "mosaicplot of activity by area",
  shade = TRUE)
```



```
xchisq.test(tally(~ activity + area, data = schooldata))
```

```
##
##  Pearson's Chi-squared test
##
## data:  x
## X-squared = 93.7, df = 6, p-value <2e-16
##
##   209      104      135
## (210.77) (143.38) ( 93.85)
## [ 0.0149] [10.8181] [18.0470]
## <-0.122> <-3.289> < 4.248>
##
##   198      171      115
## (227.71) (154.91) (101.39)
## [ 3.8754] [ 1.6720] [ 1.8277]
## <-1.969> < 1.293> < 1.352>
##
##   177      158       39
## (175.95) (119.70) ( 78.34)
## [ 0.0062] [12.2543] [19.7590]
## < 0.079> < 3.501> <-4.445>
##
##   101       33       16
## ( 70.57) ( 48.01) ( 31.42)
## [13.1215] [ 4.6918] [ 7.5689]
## < 3.622> <-2.166> <-2.751>
##
## key:
##  observed
##  (expected)
##  [contribution to X-squared]
##  <Pearson residual>
```

Section 24.3: Examining the residuals

Note that the `xchisq.test()` function displays the standardized residuals as the last item in each cell of the table (and these match the results in Table 24.4 on page 668).