# Reproduction of Analyses in Lohr (1999) using the `survey` package

Tobias Verbeke

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## Contents

# 1 Introduction

The Introduction chapter does not contain any numerical examples demonstrating survey methodology. Before reproducing the analyses of the following chapters, we load the `SDA` package

```
> library(SDA)
```

The `survey` package is loaded as well as it was specified as a dependency of the `SDA` package.

# 2 Simple Probability Samples

# 3 Ratio and Regression Estimation

## 3.1 Ratio Estimation

```
> agsrsDesign <- svydesign(ids = ~1, weights = ~1,
+     data = agsrs)
> svyratio(numerator = ~acres92, denominator = ~acres87,
+     design = agsrsDesign)
```

```
Ratio estimator: svyratio.survey.design2(numerator = ~acres92, denominator = ~acres87,
    design = agsrsDesign)
Ratios=
          acres87
```

```
> plot(I(acres92/10^6) ~ I(acres87/10^6), xlab = "Millions of Acres Devoted to Farms (
+     ylab = "Millions of Acres Devoted to Farms (1992)",
+     data = agsrs)
> abline(lm(I(acres92/10^6) ~ 0 + I(acres87/10^6),
+     data = agsrs), col = "red", lwd = 2)
```

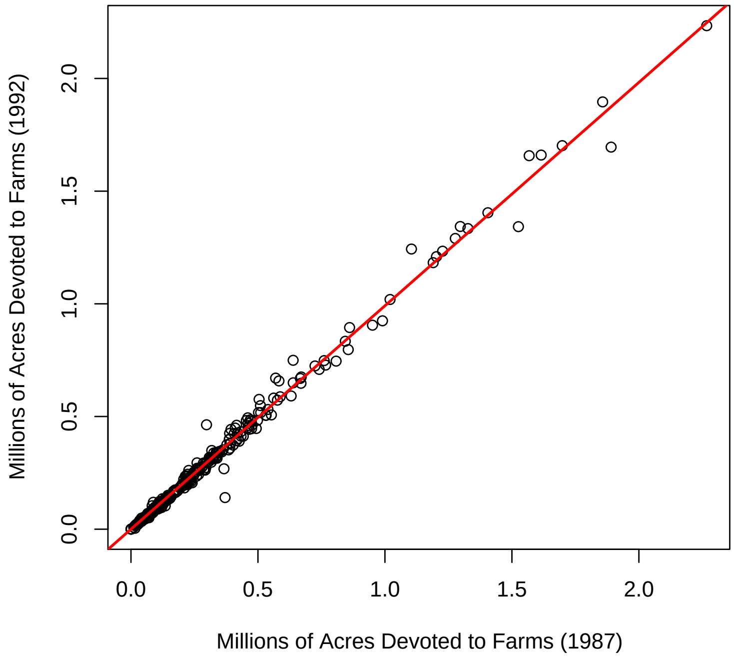



Figure 1: Figure 3.1, p. 64

```
acres92 0.9865652
SEs=
             acres87
acres92 0.006053015
```

```
> seedlings <- data.frame(tree = 1:10, x = c(1, 0,
+     8, 2, 76, 60, 25, 2, 1, 31), y = c(0, 0, 1, 2,
```

```
> plot(y ~ x, data = seedlings, xlab = "Seedlings Alive (March 1992)",
+     ylab = "Seedlings That Survived (February 1994)")
```

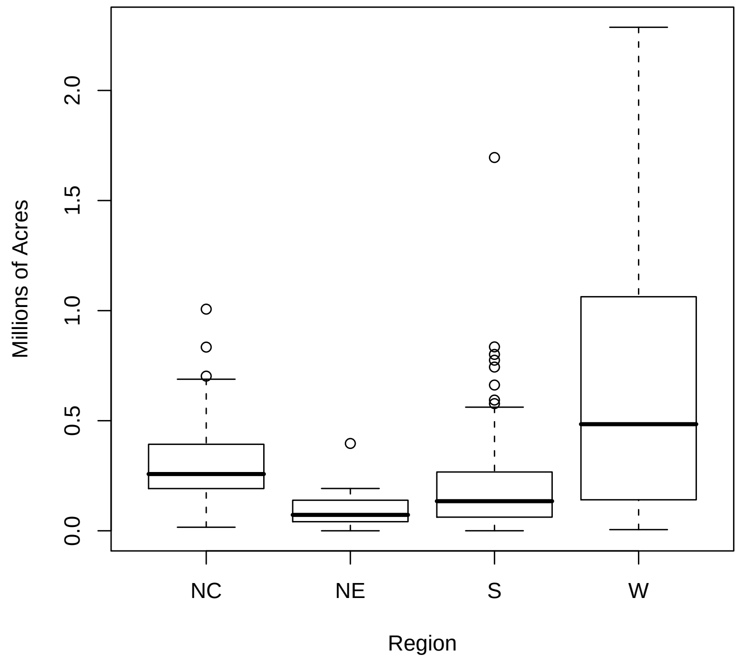



Figure 2: Figure 3.4, p. 73

```
+     10, 15, 3, 2, 1, 27))
> names(seedlings) <- c("tree", "x", "y")
```

## 3.2 Regression Estimation

```
> pf <- data.frame(photo = c(10, 12, 7, 13, 13, 6,
+     17, 16, 15, 10, 14, 12, 10, 5, 12, 10, 10, 9,
+     6, 11, 7, 9, 11, 10, 10), field = c(15, 14, 9,
+     14, 8, 5, 18, 15, 13, 15, 11, 15, 12, 8, 13,
+     9, 11, 12, 9, 12, 13, 11, 10, 9, 8))
```

```
> boxplot(acres92/10^6 ~ region, xlab = "Region", ylab = "Millions of Acres",
+     data = agstrat)
```

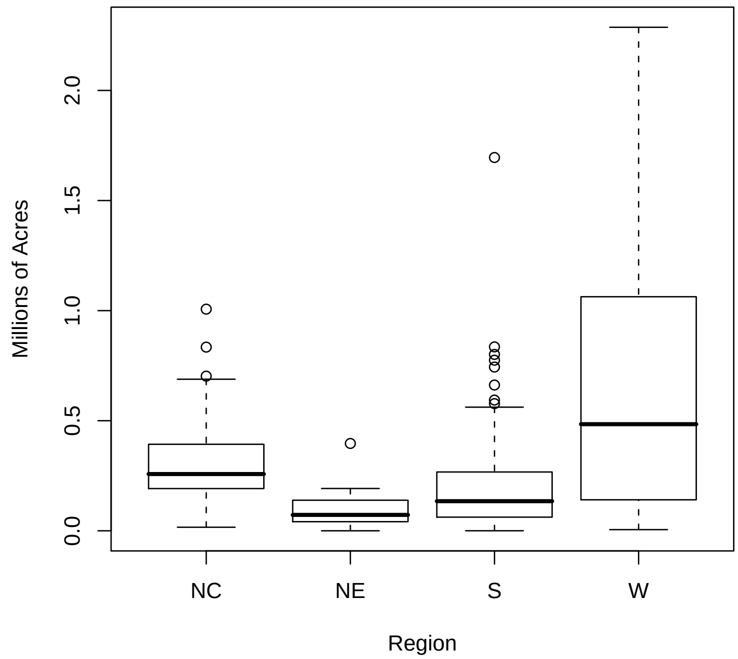



Figure 3: Figure 4.1, p. 97

## 3.3 Estimation in Domains

## 3.4 Models for Ratio and Regression Estimation

# 4 Stratified Sampling

# 5 Cluster Sampling with Equal Probabilities

## 5.1 Notation for Cluster Sampling

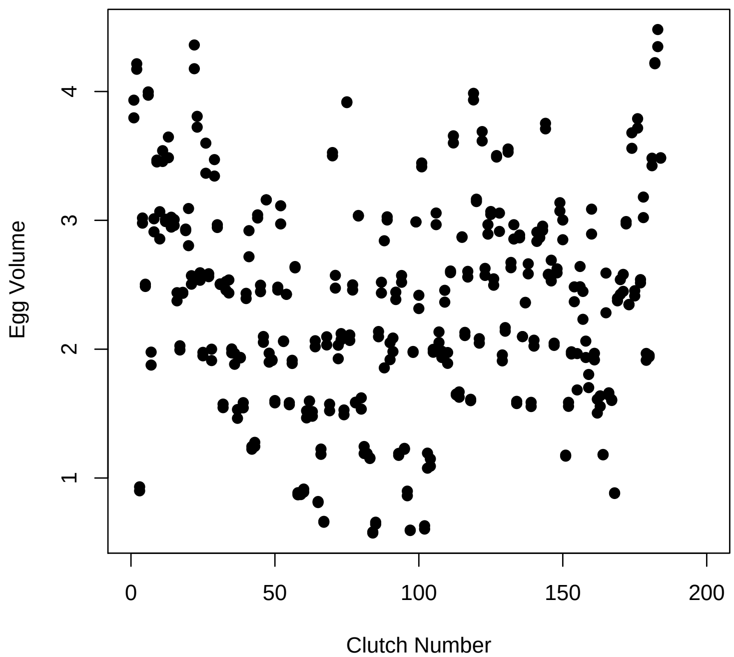
No analyses contained in this section.

## 5.2 One-Stage Cluster Sampling

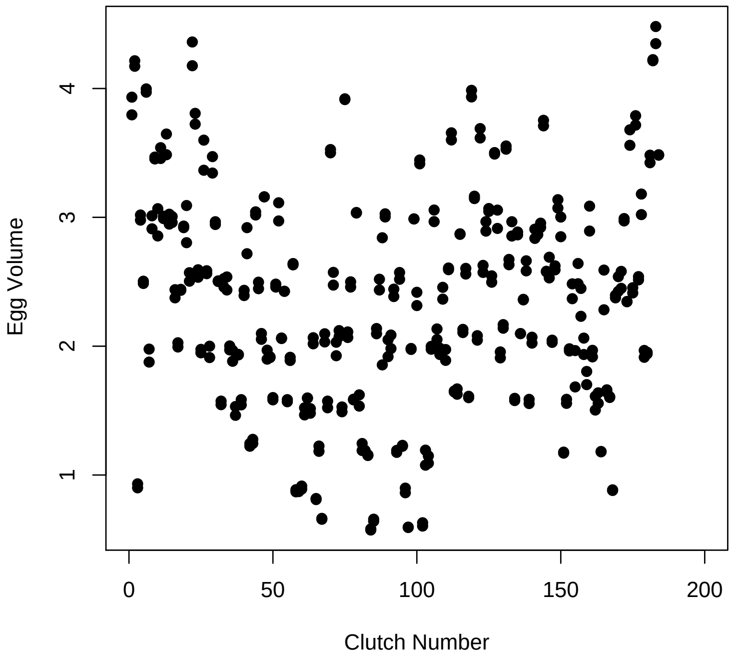
```
> GPA <- cbind(expand.grid(1:4, 1:5), gpa = c(3.08,
+     2.6, 3.44, 3.04, 2.36, 3.04, 3.28, 2.68, 2, 2.56,
+     2.52, 1.88, 3, 2.88, 3.44, 3.64, 2.68, 1.92,
+     3.28, 3.2))
> names(GPA)[1:2] <- c("person_num", "cluster")
> GPA$pwt <- 100/5
> clusterDesign <- svydesign(ids = ~cluster, weights = ~pwt,
+     data = GPA)
> svytotal(~gpa, design = clusterDesign)

     total     SE
gpa 1130.4 67.167
```

## 5.3 Two-Stage Cluster Sampling

```
> plot(volume ~ clutch, xlim = c(0, 200), pch = 19,
+     data = coots, xlab = "Clutch Number", ylab = "Egg Volume")
```

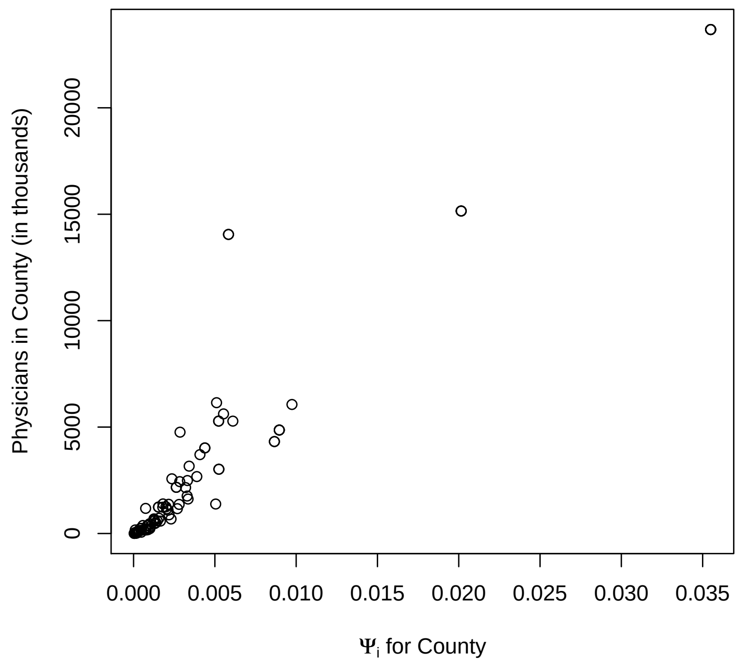



```
> plot(volume ~ clutch, xlim = c(0, 200), pch = 19,
+      data = coots, xlab = "Clutch Number", ylab = "Egg Volume")
```




# 6 Sampling with Unequal Probabilities

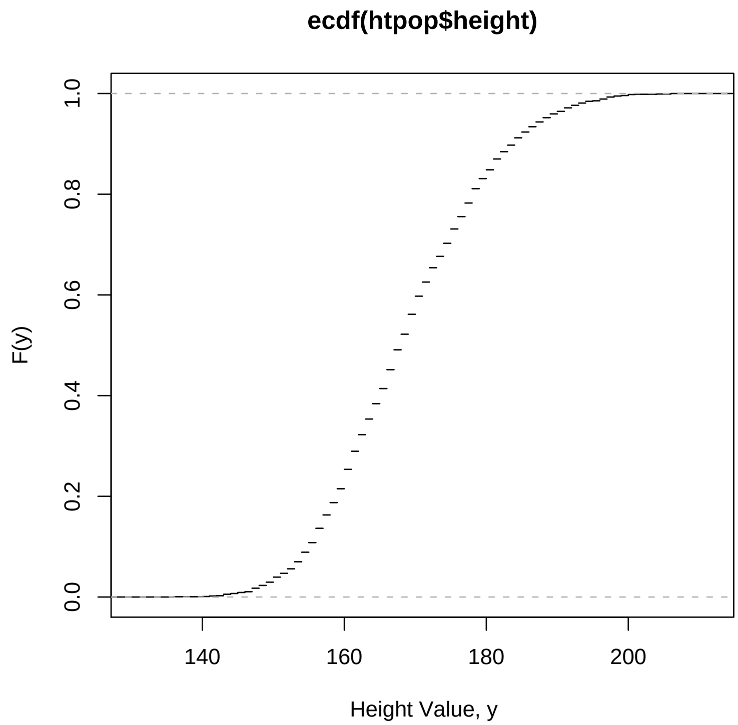
```
> data(statepop)
> statepop$psi <- statepop$popn/255077536

> plot(phys ~ psi, data = statepop, xlab = expression(paste(Psi[i],
+     " for County")), ylab = "Physicians in County (in thousands)")
```



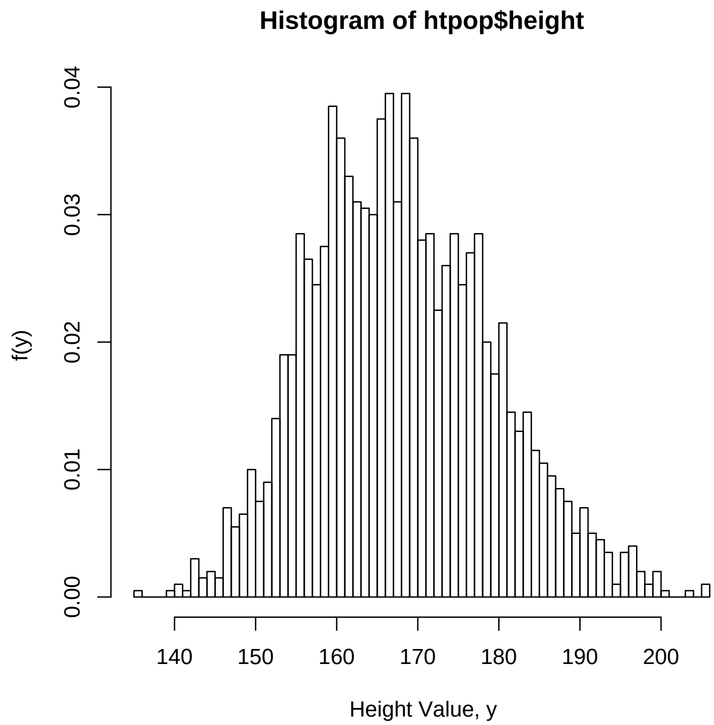

# 7 Complex Surveys

## 7.1 Estimating a Distribution Function

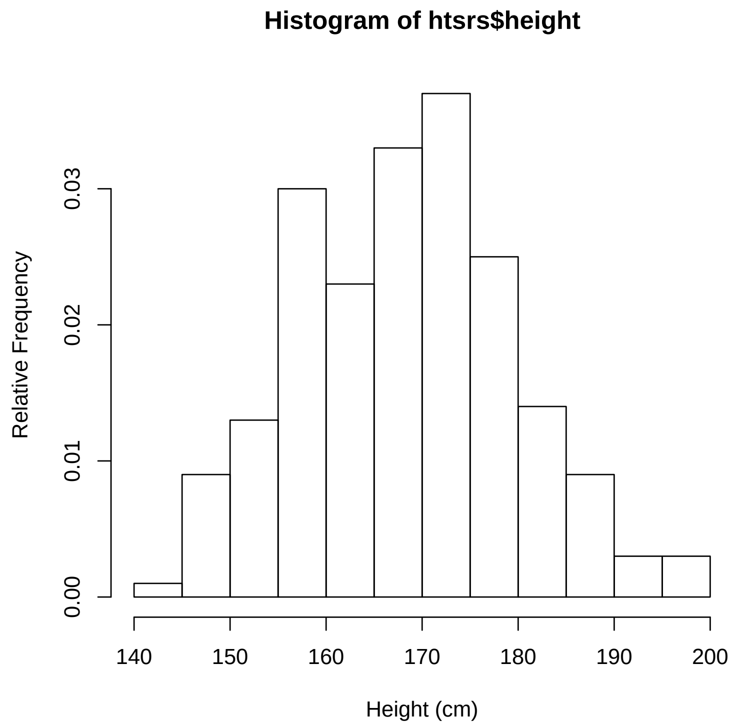
```
> data(htpop)
> popecdf <- ecdf(htpop$height)
> plot(popecdf, do.points = FALSE, ylab = "F(y)", xlab = "Height Value, y")
```




```
> minht <- min(htpop$height)
> breaks <- c(minht - 1, seq(from = minht, to = max(htpop$height),
+     by = 1))
> hist(htpop$height, ylab = "f(y)", breaks = breaks,
+     xlab = "Height Value, y", freq = FALSE)
```

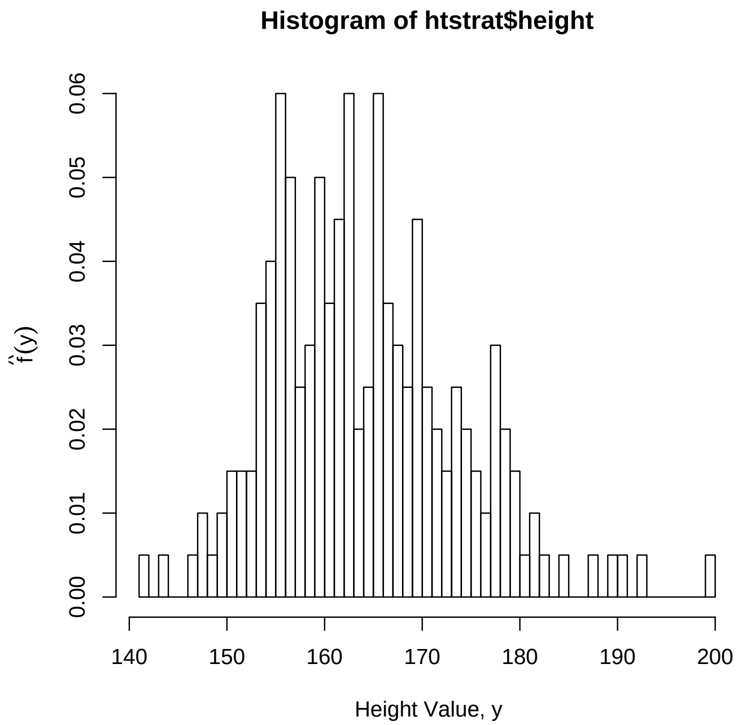



```
> data(htsrs)
> hist(htsrs$height, ylab = "Relative Frequency", xlab = "Height (cm)",
+      freq = FALSE)
```

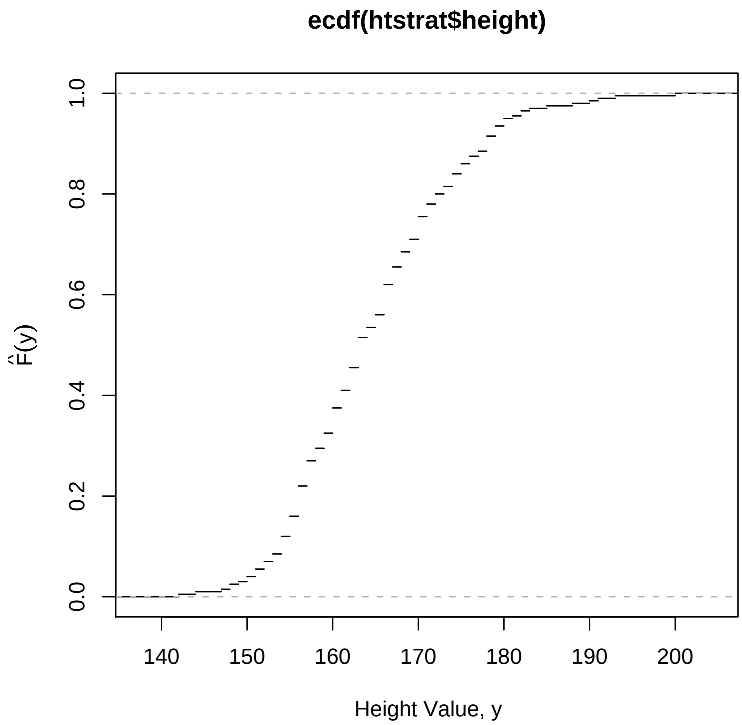



```
> data(htstrat)
> hist(htstrat$height, ylab = "Relative Frequency",
+      xlab = "Height (cm)", freq = FALSE)
```


```
> minht <- min(htstrat$height)
> breaks <- c(minht - 1, seq(from = minht, to = max(htstrat$height),
+     by = 1))
> hist(htstrat$height, ylab = expression(hat(f)(y)),
+     breaks = breaks, xlab = "Height Value, y", freq = FALSE)
```

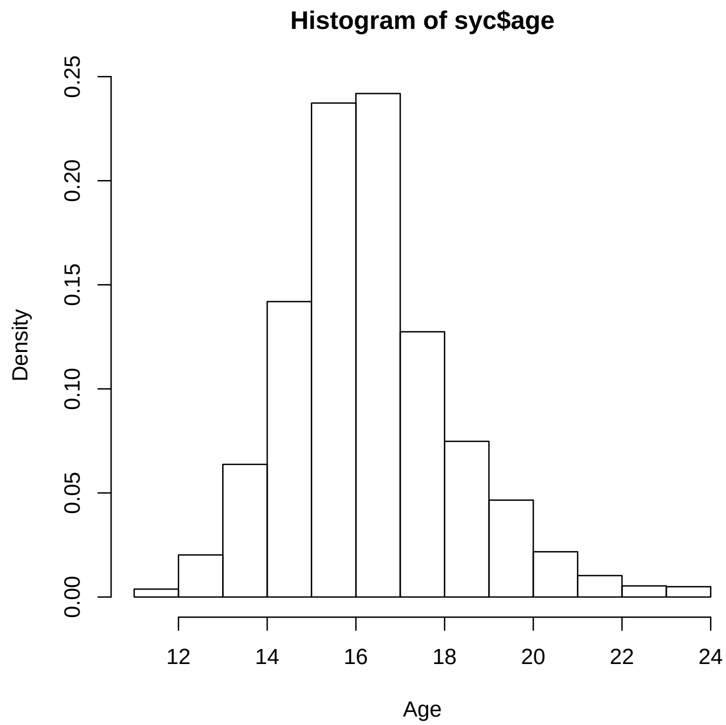



```
> stratecdf <- ecdf(htstrat$height)
> plot(stratecdf, do.points = FALSE, ylab = expression(hat(F)(y)),
+     xlab = "Height Value, y")
```



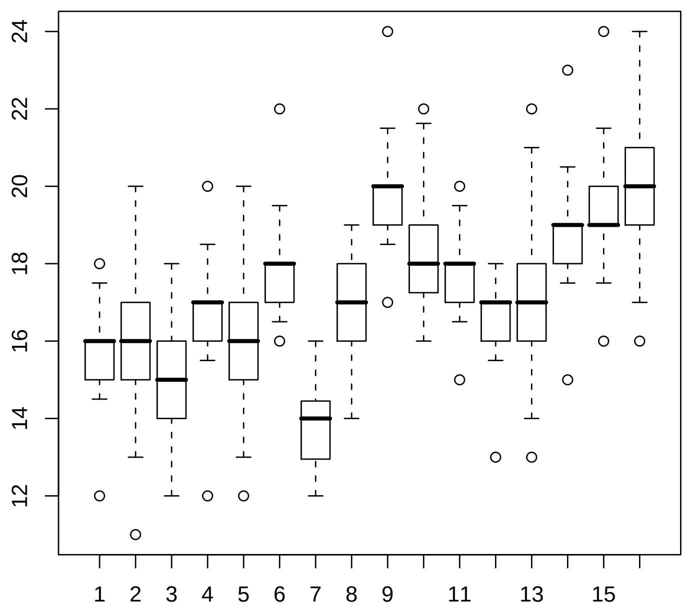

## 7.2 Plotting Data from a Complex Survey

```
> data(syc)
> hist(syc$age, freq = FALSE, xlab = "Age")
```



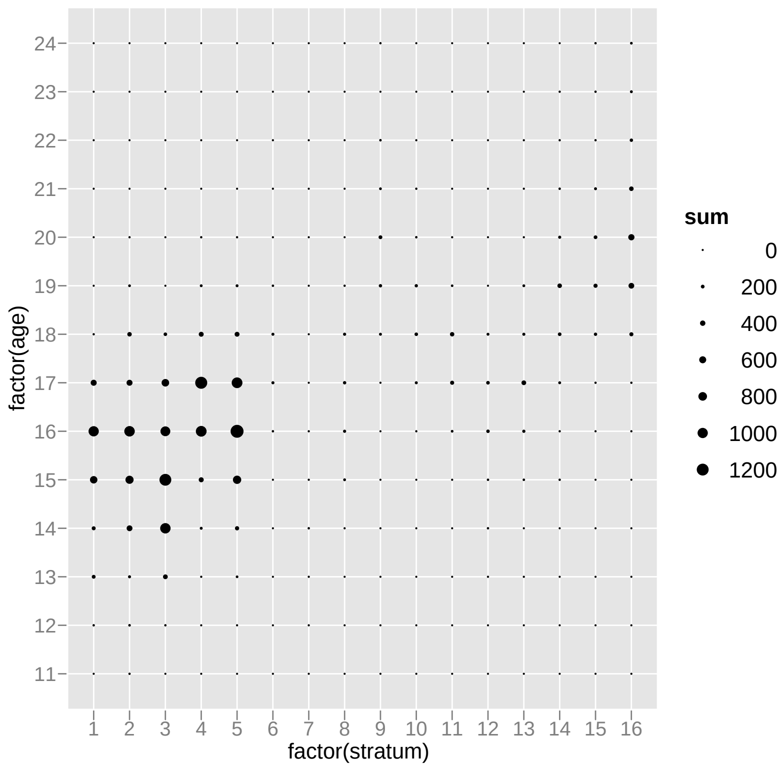

Note that in its current implementation, `svyboxplot` will only plot minimum and maximum as outliers if they are situated outside the whiskers. Other outliers are not plotted (see `?svyboxplot`). This explains the minor difference with Figure 7.8 on p. 237 of Lohr (1999).

```
> sycdesign <- svydesign(ids = ~psu, strata = ~stratum,
+     data = syc, weights = ~finalwt)
> oo <- options(survey.lonely.psu = "certainty")
> svyboxplot(age ~ factor(stratum), design = sycdesign)
> options(oo)
```



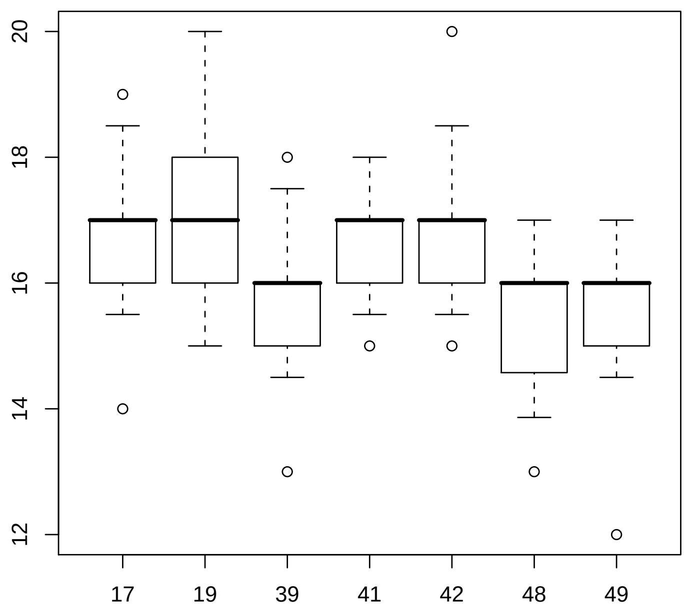

This kind of plot is particularly easy to formulate in the grammar of graphics, i.e. using the `ggplot2` package :

```
> p <- ggplot(syc, aes(x = factor(stratum), y = factor(age)))
> g <- p + stat_sum(aes(group = 1, weight = finalwt,
+     size = ..sum..))
> print(g)
```

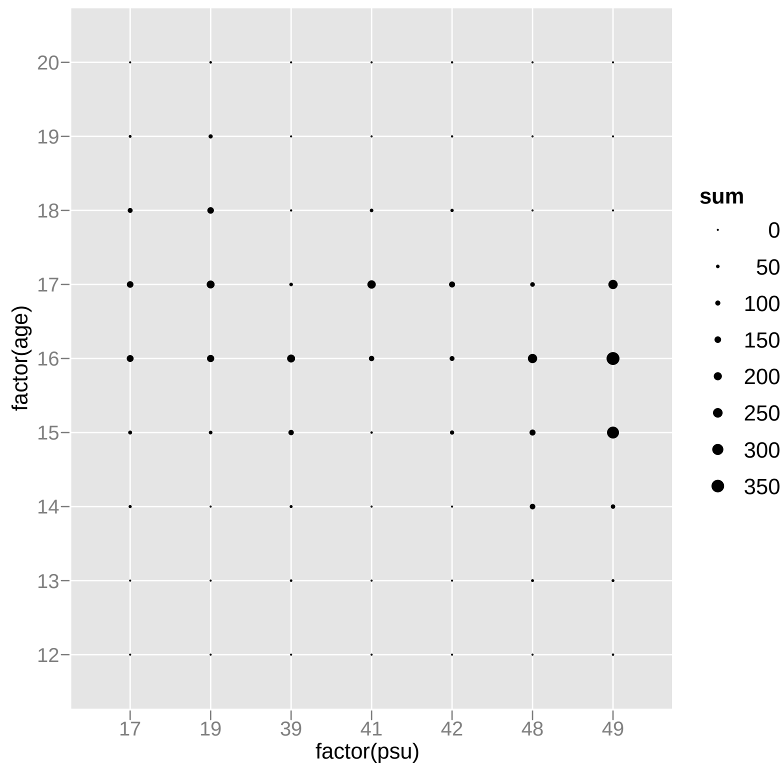



Note that in its current implementation, `svyboxplot` will only plot minimum and maximum as outliers if they are situated outside the whiskers. Other outliers are not plotted (see `?svyboxplot`). This explains the minor difference with Figure 7.10 on p. 238 of Lohr (1999).

```
> oo <- options(survey.lonely.psu = "certainty")
> sycstrat5 <- subset(sycdesign, stratum == 5)
> svyboxplot(age ~ factor(psu), design = sycstrat5)
> options(oo)
```




```
> sycstrat5df <- subset(syc, stratum == 5)
> p <- ggplot(sycstrat5df, aes(x = factor(psu), y = factor(age)))
> g <- p + stat_sum(aes(group = 1, weight = finalwt,
+     size = ..sum..))
> print(g)
```




# 8 Nonresponse

# 9 Variance Estimation in Complex Surveys

# 10 Categorical Data Analysis in Complex Surveys

## 10.1 Chi-Square Tests with Multinomial Sampling

```
> hh <- rbind(c(119, 188), c(88, 105))
> rownames(hh) <- c("cableYes", "cableNo")
> colnames(hh) <- c("computerYes", "computerNo")
> addmargins(hh)
```

```
         computerYes computerNo Sum
cableYes         119        188 307
cableNo           88        105 193
Sum              207        293 500

> chisq.test(hh, correct = FALSE)

        Pearson's Chi-squared test

data:  hh
X-squared = 2.281, df = 1, p-value = 0.1310

> nst <- rbind(c(46, 222), c(41, 109), c(17, 40), c(8,
+     26))
> colnames(nst) <- c("NR", "R")
> rownames(nst) <- c("generalStudent", "generalTutor",
+     "psychiatricStudent", "psychiatricTutor")
> addmargins(nst)

                    NR   R Sum
generalStudent      46 222 268
generalTutor        41 109 150
psychiatricStudent  17  40  57
psychiatricTutor     8  26  34
Sum                112 397 509

> chisq.test(nst, correct = FALSE)

        Pearson's Chi-squared test

data:  nst
X-squared = 8.2176, df = 3, p-value = 0.04172

> afp <- data.frame(nAccidents = 0:7, nPilots = c(12475,
+     4117, 1016, 269, 53, 14, 6, 2))
> lambdahat <- sum(afp$nAccidents * afp$nPilots/sum(afp$nPilots))
> observed <- afp$nPilots
> expected <- dpois(0:7, lambda = lambdahat) * sum(afp$nPilots)
> sum((observed - expected)^2/expected)

[1] 1935.127
```

## 10.2 Effects of Survey Design on Chi-Square Tests

```
> hh2 <- rbind(c(238, 376), c(176, 210))
> rownames(hh2) <- c("cableYes", "cableNo")
> colnames(hh2) <- c("computerYes", "computerNo")
> addmargins(hh2)

         computerYes computerNo  Sum
cableYes         238        376  614
cableNo          176        210  386
Sum              414        586 1000

> chisq.test(hh2, correct = FALSE)

        Pearson's Chi-squared test

data:  hh2
X-squared = 4.5621, df = 1, p-value = 0.03269
```

## 10.3 Corrections to Chi-Square Tests

# 11 Regression with Complex Survey Data

# 12 Other Topics in Sampling