

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

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Contents

Contents	1
1 Introduction	2
2 Simple Probability Samples	3
3 Ratio and Regression Estimation	3
3.1 Ratio Estimation	3
3.2 Regression Estimation	3
3.3 Estimation in Domains	6
3.4 Models for Ratio and Regression Estimation	6
4 Stratified Sampling	6
5 Cluster Sampling with Equal Probabilities	6
5.1 Notation for Cluster Sampling	6
5.2 One-Stage Cluster Sampling	8
5.3 Two-Stage Cluster Sampling	9
6 Sampling with Unequal Probabilities	10
7 Complex Surveys	11
7.1 Estimating a Distribution Function	11
7.2 Plotting Data from a Complex Survey	17

8	Nonresponse	23
9	Variance Estimation in Complex Surveys	23
9.1	Linearization (Taylor Series) Methods	23
9.2	Random Group Methods	23
9.3	Resampling and Replication Methods	23
9.4	Generalized Variance Functions	23
9.5	Confidence Intervals	23
10	Categorical Data Analysis in Complex Surveys	23
10.1	Chi-Square Tests with Multinomial Sampling	23
10.2	Effects of Survey Design on Chi-Square Tests	24
10.3	Corrections to Chi-Square Tests	25
11	Regression with Complex Survey Data	25
11.1	Model-Based Regression in Simple Random Samples	25
11.2	Regression in Complex Surveys	25
12	Other Topics in Sampling	25

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 `SDaA` package as well as the `survey`

```
> library(SDaA)
> library(survey)
```

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

2 Simple Probability Samples

3 Ratio and Regression Estimation

3.1 Ratio Estimation

```
> ### Example 3.2, p. 63
> agsrsDesign <- svydesign(ids=~1, weights = ~1, data = agsrs)
> svyratio(numerator = ~acres92, denominator = ~acres87,
+         design = agsrsDesign) # proportion B hat
```

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

```
Ratios=
```

```
      acres87
```

```
acres92 0.9865652
```

```
SEs=
```

```
      acres87
```

```
acres92 0.006053015
```

```
> ### Example 3.5, p. 72, table 3.3
> seedlings <- data.frame(tree = 1:10,
+       x = c(1, 0, 8, 2, 76, 60, 25, 2, 1, 31),
+       y = c(0, 0, 1, 2, 10, 15, 3, 2, 1, 27))
> names(seedlings) <- c("tree", "x", "y")
```

3.2 Regression Estimation

```
> ### Example 3.6, p. 75
> 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))
```

```
> ### part of Example 3.2, p. 64
> plot(I(acres92/10^6) ~ I(acres87/10^6),
+      xlab = "Millions of Acres Devoted to Farms (1987)",
+      ylab = "Millions of Acres Devoted to Farms (1992)", data = agsrs)
> abline(lm(I(acres92/10^6) ~ 0 + I(acres87/10^6), # through the origin
+        data = agsrs), col = "red", lwd = 2)
```

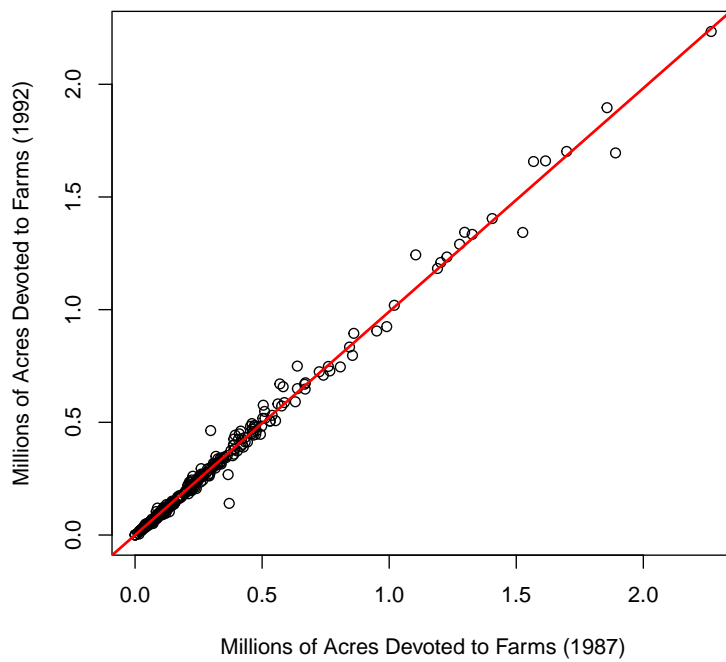


Figure 1: Figure 3.1, p. 64

```
> plot(y ~ x, data = seedlings, xlab = "Seedlings Alive (March 1992)",  
+      ylab = "Seedlings That Survived (February 1994)")  
> # abline(lm(y ~ 0 + x, data = seedlings), lwd = 2, col = "red")  
> # TODO: add proper abline
```

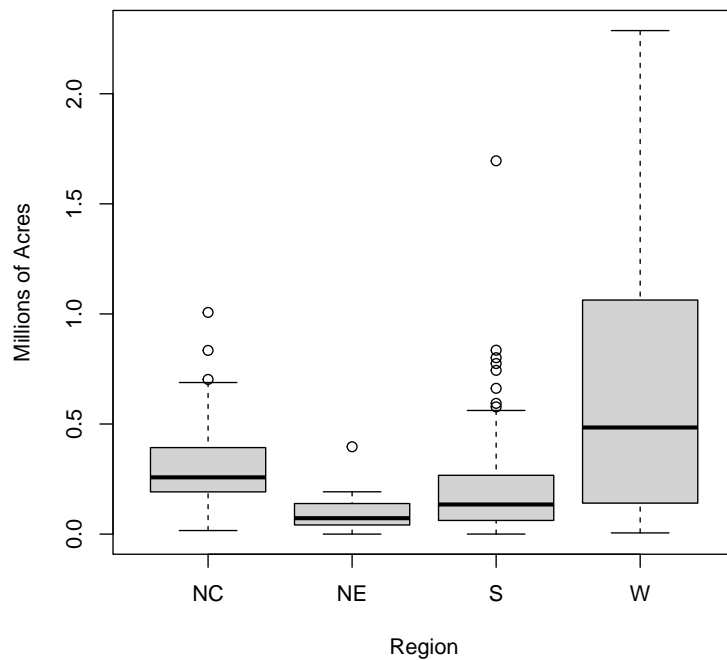


Figure 2: Figure 3.4, p. 73

3.3 Estimation in Domains

3.4 Models for Ratio and Regression Estimation

```
>      ### Example 3.9, p. 83
> recacr87 <- agsrs$acres87
> recacr87[recacr87 > 0] <- 1/recacr87[recacr87 > 0] # cf. p. 450
> model1 <- lm(acres92 ~ 0 + acres87, weights = recacr87, data = agsrs)
> summary(model1)
```

Call:

```
lm(formula = acres92 ~ 0 + acres87, data = agsrs, weights = recacr87)
```

Weighted Residuals:

Min	1Q	Median	3Q	Max
-369.88	-22.09	-5.74	10.76	311.71

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
acres87	0.986565	0.004844	203.7	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 46.1 on 298 degrees of freedom

Multiple R-squared: 0.9929, Adjusted R-squared: 0.9928

F-statistic: 4.149e+04 on 1 and 298 DF, p-value: < 2.2e-16

4 Stratified Sampling

5 Cluster Sampling with Equal Probabilities

5.1 Notation for Cluster Sampling

No analyses contained in this section.

```
> ### Figure 3.6, p. 85
> wtresid <- resid(model1) / sqrt(agsrs$acres87)
> plot(wtresid ~ I(agsrs$acres87/10^6),
+       xlab = "Millions of Acres Devoted to Farms (1987)",
+       ylab = "Weighted Residuals")
```

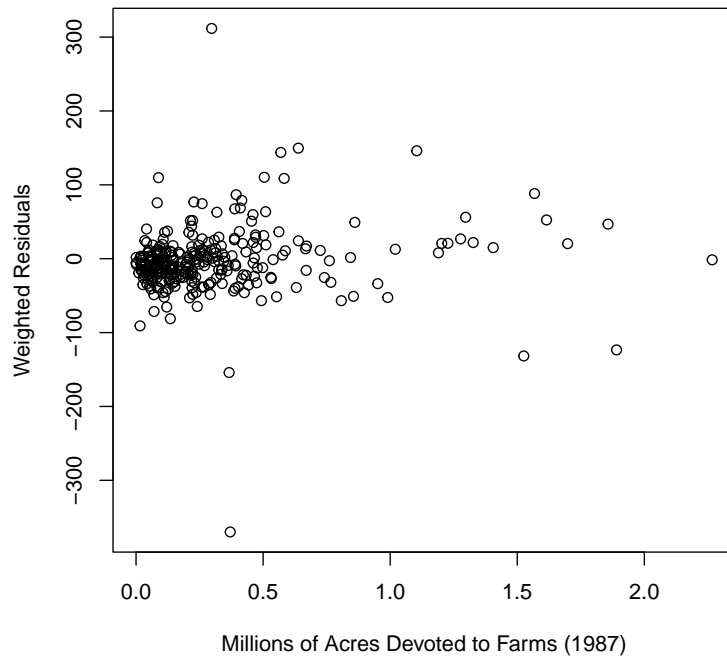


Figure 3: Figure 3.6, p. 85

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

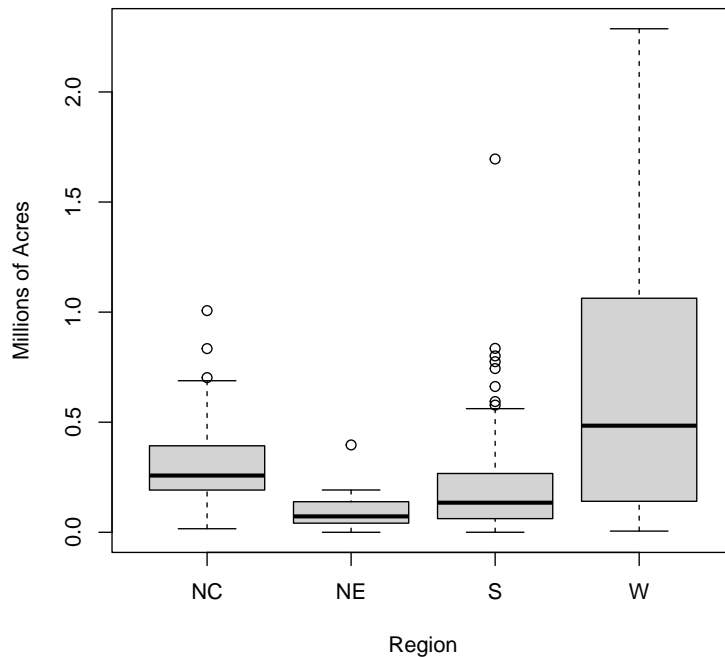


Figure 4: Figure 4.1, p. 97

5.2 One-Stage Cluster Sampling

```
> ### Example 5.2, p. 137 middle
> GPA <- cbind(expand.grid(1:4, 1:5),
+             gpa = c(3.08, 2.60, 3.44, 3.04, 2.36, 3.04, 3.28, 2.68, 2.00, 2.56,
+                   2.52, 1.88, 3.00, 2.88, 3.44, 3.64, 2.68, 1.92, 3.28, 3.20))
> 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

> #      total      SE
> # gpa 1130.4 67.167
>
> # Stata results: 1130.4    67.16666 ---> corresponds perfectly

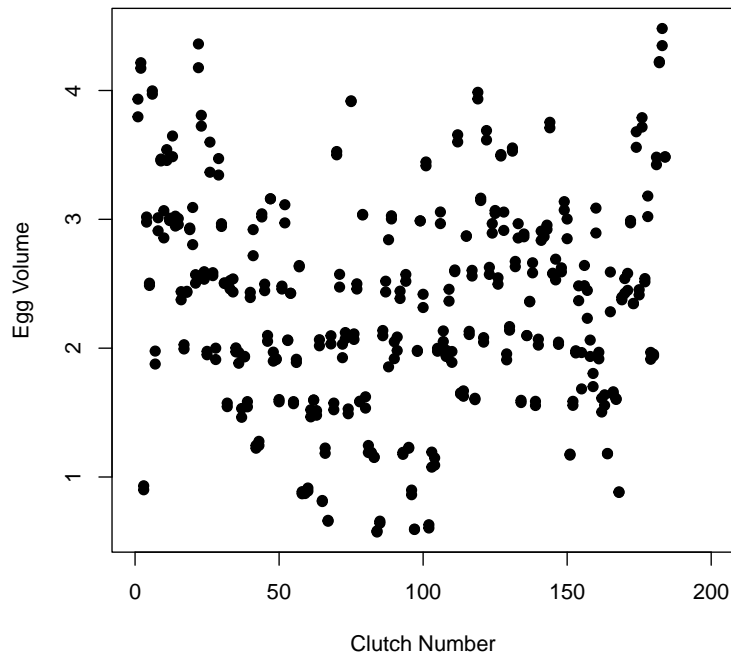
```

5.3 Two-Stage Cluster Sampling

```

> ### Figure 5.3
>     plot(volume ~ clutch, xlim = c(0,200), pch=19, data = coots,
+       xlab = "Clutch Number", ylab = "Egg Volume")

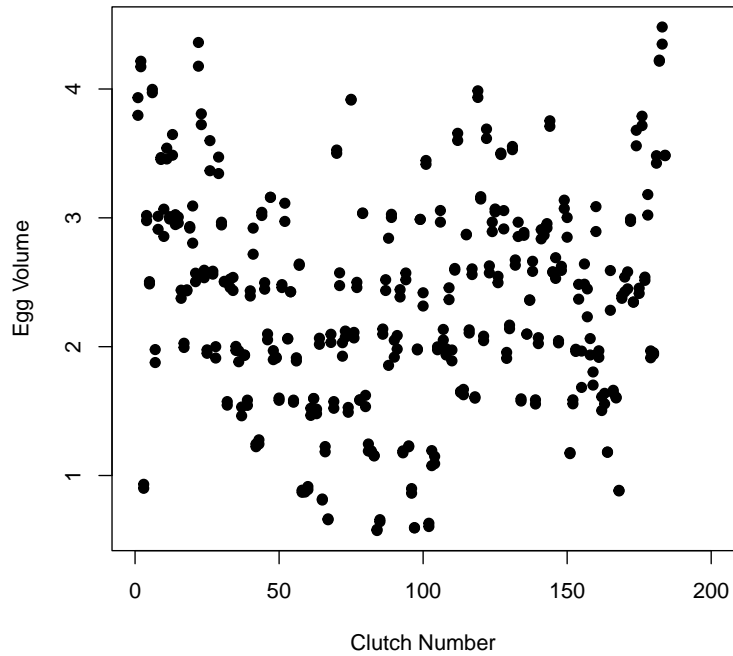
```



```

> ### Figure 5.3
>     plot(volume ~ clutch, xlim = c(0,200), pch=19, data = coots,
+       xlab = "Clutch Number", ylab = "Egg Volume")

```



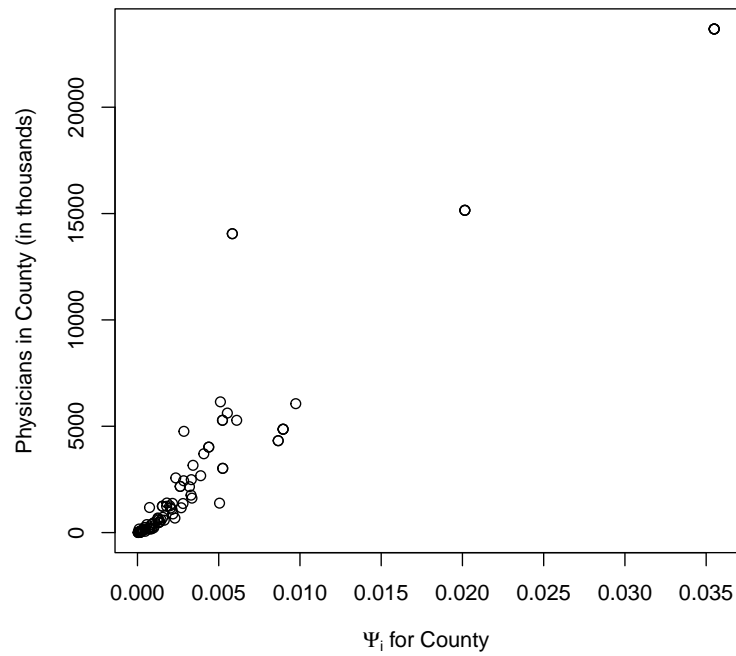
6 Sampling with Unequal Probabilities

```

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

>     ### page 191, figure 6.1
> plot(phys ~ psi, data = statepop,
+       xlab = expression(paste(Psi[i], " for County")),
+       ylab = "Physicians in County (in thousands)")

```



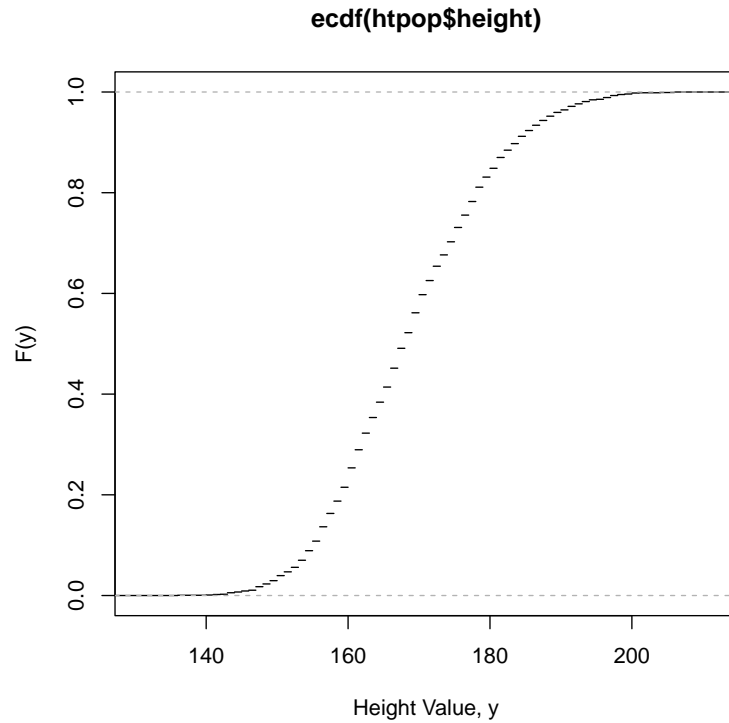
7 Complex Surveys

7.1 Estimating a Distribution Function

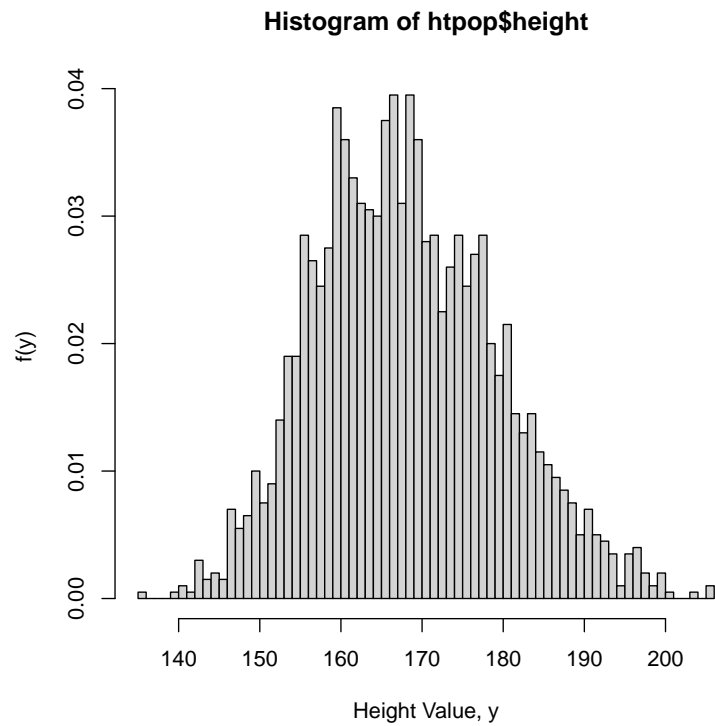
```

>     ### Figure 7.1
> data(htpop)
> popecdf <- ecdf(htpop$height)
> plot(popecdf, do.points = FALSE, ylab = "F(y)",
+      xlab = "Height Value, y")

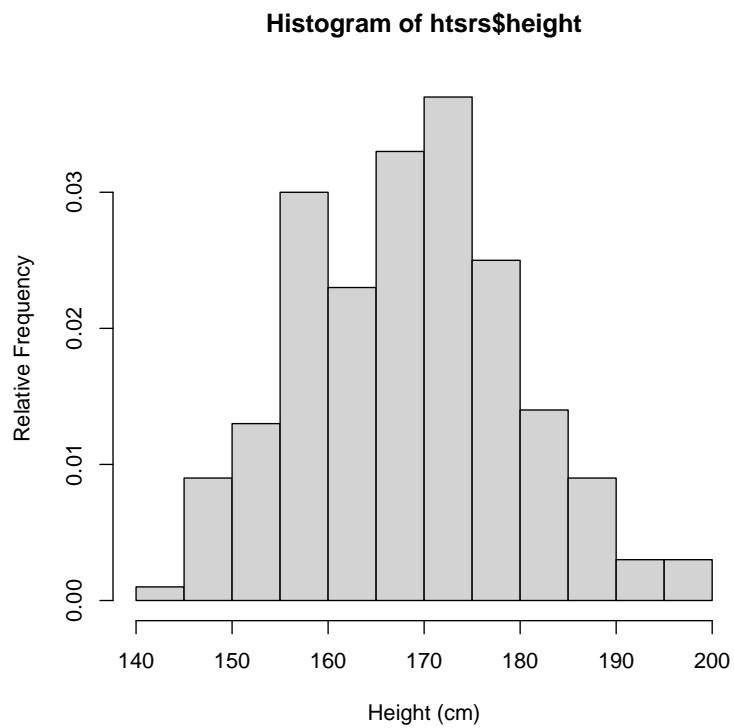
```



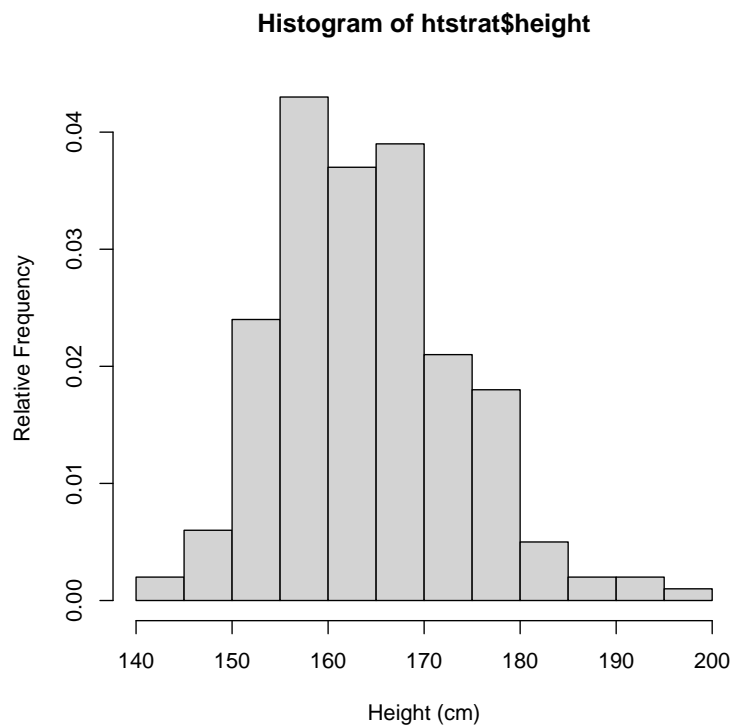
```
> ### Figure 7.2
> minht <- min(htpop$height)
> breaks <- c(minht-1, seq(from = minht, to = max(htpop$height), by = 1))
> hist(htpop$height, ylab = "f(y)", breaks = breaks,
+       xlab = "Height Value, y", freq = FALSE)
```



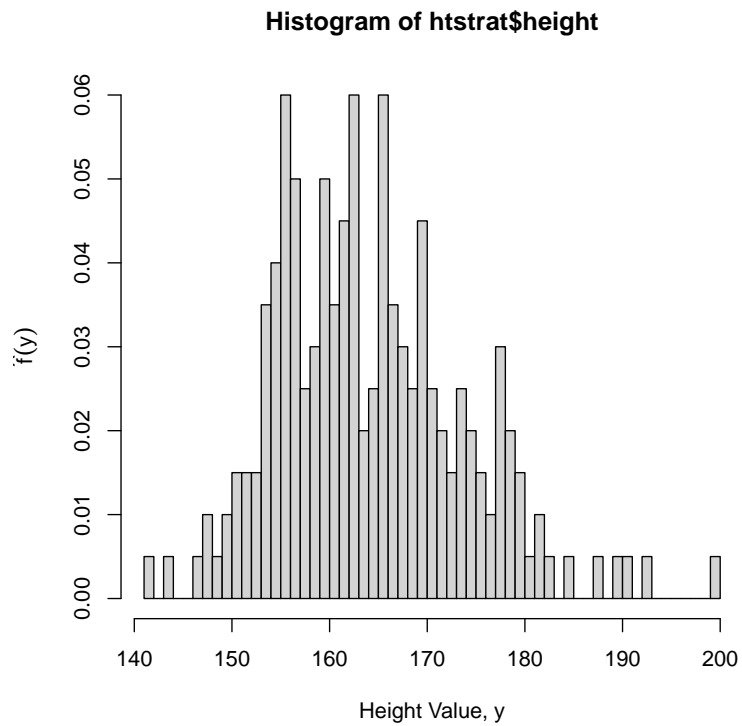
```
> ### Figure 7.3
> data(htsrs)
> hist(htsrs$height, ylab = "Relative Frequency",
+       xlab = "Height (cm)", freq = FALSE)
```



```
> ### Figure 7.4  
> data(htstrat)  
> hist(htstrat$height, ylab = "Relative Frequency",  
+      xlab = "Height (cm)", freq = FALSE)
```



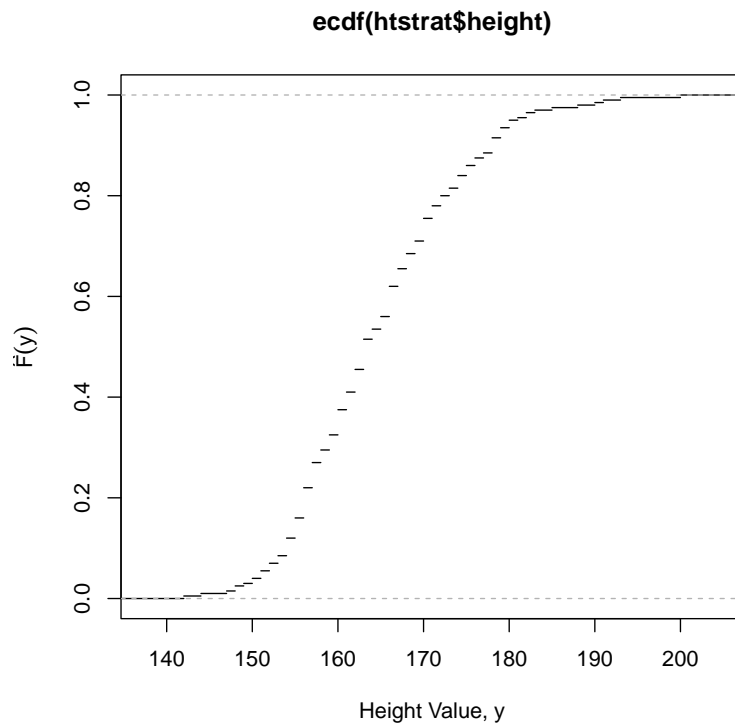
```
>     ### Figure 7.5 (a)
> minht <- min(htstrat$height)
> breaks <- c(minht-1, seq(from = minht, to = max(htstrat$height), by = 1))
> hist(htstrat$height, ylab = expression(hat(f)(y)), breaks = breaks,
+       xlab = "Height Value, y", freq = FALSE)
```



```

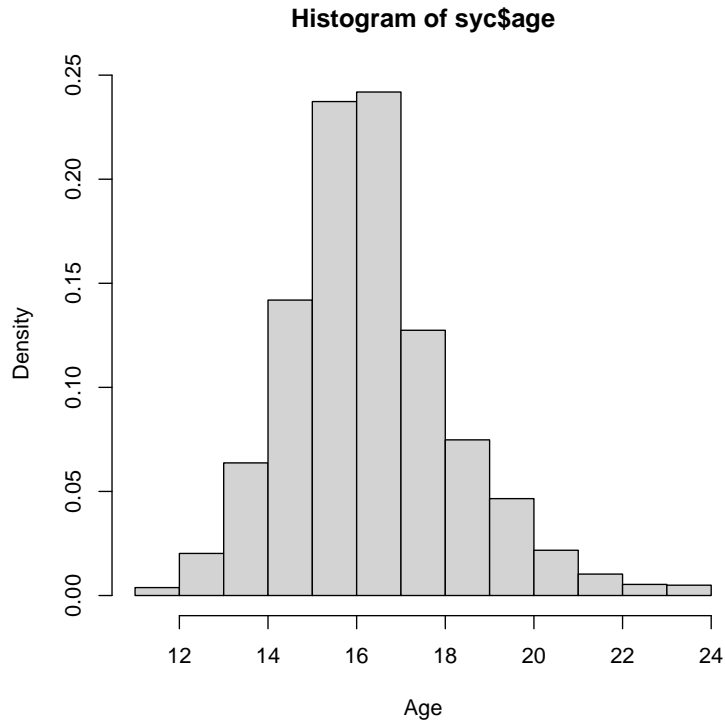
> ### Figure 7.5 (b)
> stratecdf <- ecdf(htstrat$height)
> plot(stratecdf, do.points = FALSE, ylab = expression(hat(F)(y)),
+       xlab = "Height Value, y")

```

7.2 Plotting Data from a Complex Survey

```
>     ### Figure 7.6  
> data(syc)  
> hist(syc$age, freq = FALSE, xlab = "Age")
```

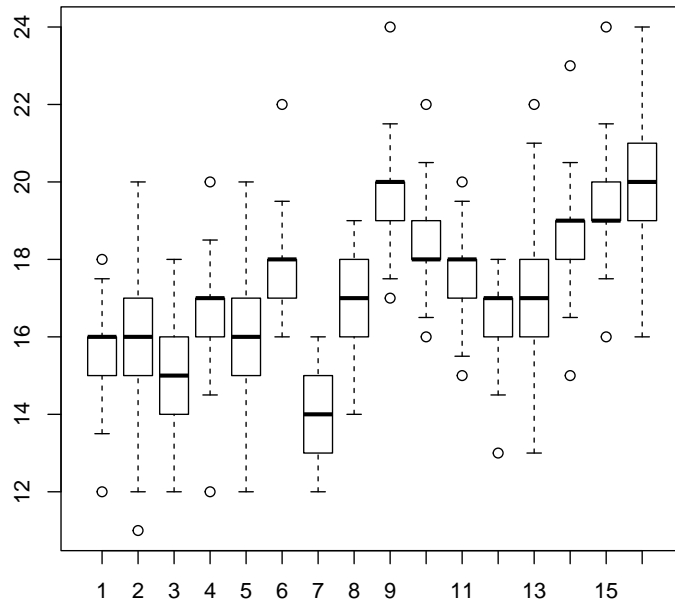


Note that in its current implementation, `svyboxplot` will only plot minimum and maximum as outliers if they are situated outside the whiskers. Other outliers are not plotted (see `?svyboxplot`). This explains the minor difference with Figure 7.8 on p. 237 of Lohr (1999).

```

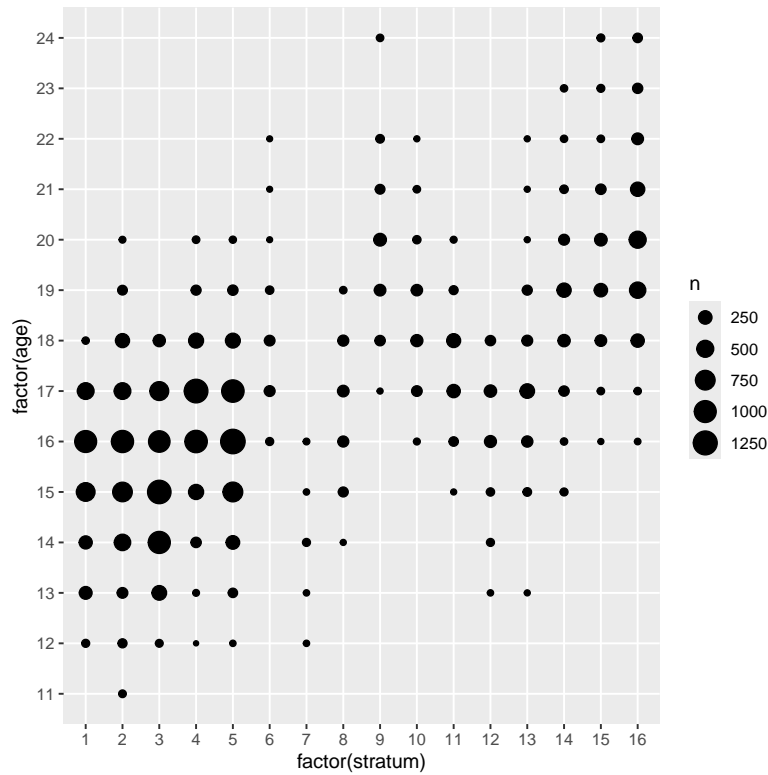
> ### Figure 7.8
> sycdesign <- svydesign(ids= ~ psu, strata = ~ stratum,
+   data = syc, weights=~finalwt)
> # p. 235: "Each of the 11 facilities with 360 or more youth
> # formed its own stratum (strata 6-16)", so in order
> # to avoid a lonely.psu error message
> # Error in switch(lonely.psu, certainty = scale * crossprod(x), remove = scale *
> #   Stratum (6) has only one PSU at stage 1
> # we set the option to "certainty" for this example
> # to see the problem, use: by(syc$psu, syc$stratum, unique)
> oo <- options(survey.lonely.psu = "certainty")
> svyboxplot(age ~ factor(stratum), design = sycdesign) # mind the factor
> options(oo)

```



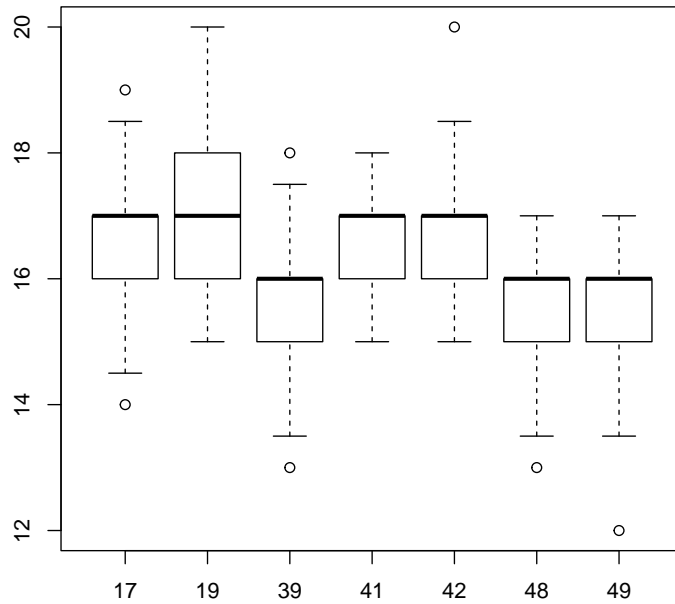
This kind of plot is particularly easy to formulate in the grammar of graphics, i.e. using the `ggplot2` package :

```
> ### Figure 7.9
> library(ggplot2)
> p <- ggplot(syc, aes(x = factor(stratum), y = factor(age)))
> g <- p + stat_sum(aes(group=1, weight = finalwt, size = ..n..))
> 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).

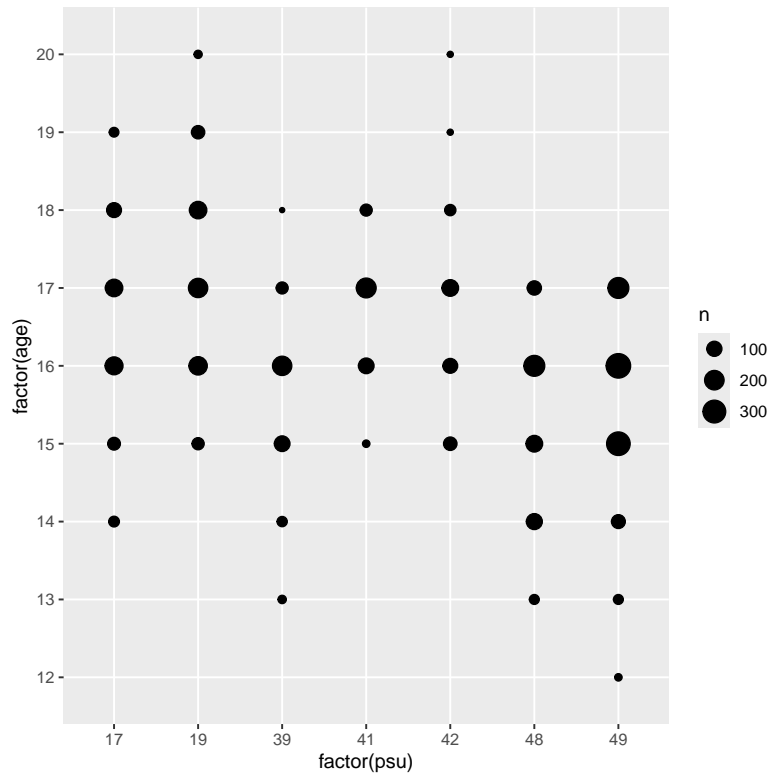
```
>     ### Figure 7.10
> oo <- options(survey.lonely.psu = "certainty")
> sycstrat5 <- subset(sycdesign, stratum == 5)
> svyboxplot(age ~ factor(psu), design = sycstrat5)
> options(oo)
```



```

> ### Figure 7.11
> 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 = ..n..))
> print(g)

```



8 Nonresponse

9 Variance Estimation in Complex Surveys

9.1 Linearization (Taylor Series) Methods

9.2 Random Group Methods

9.3 Resampling and Replication Methods

9.4 Generalized Variance Functions

9.5 Confidence Intervals

10 Categorical Data Analysis in Complex Surveys

10.1 Chi-Square Tests with Multinomial Sampling

```
> ### Example 10.1
> 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) # OK
```

Pearson's Chi-squared test

```
data: hh
X-squared = 2.281, df = 1, p-value = 0.131
```

```

>     ### Example 10.2 (nursing students and tutors)
> 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) # OK

```

Pearson's Chi-squared test

```

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

```

```

>     ### Example 10.3 (Air Force Pilots)
> afp <- data.frame(nAccidents = 0:7,
+                  nPilots = c(12475, 4117, 1016, 269, 53, 14, 6, 2))
> # estimate lambda
> lambdahat <- sum(afp$nAccidents * afp$nPilots / sum(afp$nPilots))
> # expected counts
> observed <- afp$nPilots
> expected <- dpois(0:7, lambda = lambdahat) * sum(afp$nPilots)
> sum((observed - expected)^2 / expected) # NOT OK

```

```
[1] 1935.127
```

10.2 Effects of Survey Design on Chi-Square Tests

```

>     ### Example 10.4
> 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) # OK

```

Pearson's Chi-squared test

data: hh2

X-squared = 4.5621, df = 1, p-value = 0.03269

10.3 Corrections to Chi-Square Tests

```

> ### example 10.5

```

11 Regression with Complex Survey Data

11.1 Model-Based Regression in Simple Random Samples

11.2 Regression in Complex Surveys

12 Other Topics in Sampling