Confidence Intervals for Proportions

A binomial proportion has counts for two levels of a nominal variable. An example would be counts of students of only two sexes, male and female. If there are 20 students in a class, and 12 are female, then the proportion of females are 12/20, or 0. 6, and the proportion of males are 8/20 or 0.4. This is a binomial proportion.

Sex	Count	Proportion
Female	12	0.60
Male	8	0.40
Total	20	1.00

A multinomial proportion has counts for more than two levels of a nominal variable. For example, we might have the following levels and counts for sex for students in a class:

Sex	Count	Proportion
Female	12	0.60
Male	6	0.30
Other	1	0.05
Prefer not to answer	1	0.05
Total	20	1.00

Confidence intervals can be produced for either binomial or multinomial proportions.

The *binom.test* function in the native *stats* package will provide the Clopper-Pearson confidence interval for a binomial proportion. Other methods for a binomial proportion are provided by the *BinomCI* function in the *DescTools* package, as well as by various functions in the *PropCIs* package.

Confidence intervals for multinomial proportions can be produced with the *MultinomCI* function in the *DescTools* package.

Packages used in this chapter

The packages used in this chapter include:

- DescTools
- PropCIs

The following commands will install these packages if they are not already installed:

```
if(!require(DescTools)){install.packages("DescTools")}
if(!require(PropCIs)){install.packages("PropCIs")}
```

Example of confidence intervals for a binomial proportion

As part of a demographic survey of her scrapbooking 4-H course, Seras Victoria asks students if they have ever done scrapbooking before. The following are the data from her course:

Experience	Count
Yes	7
No	14
Total	21

Note that when calculating confidence intervals for a binomial variable, one level of the nominal variable is chosen to be the “success” level. This is an arbitrary decision, but you should be cautious

to remember that the confidence interval is reported for the proportion of "success" responses. The *BinomCI* function in the *DescTools* package can produce the confidence interval for both "success" and "failure" in one step.

The *binom.test* function output includes a confidence interval for the proportion, and the proportion of "success" as a decimal number. The *binom.test* function uses the Clopper–Pearson method for confidence intervals.

```
binom.test(7, 21,
           0.5,
           alternative="two.sided",
           conf.level=0.95)

    95 percent confidence interval:
     0.1458769 0.5696755

    sample estimates:
    probability of success
                  0.3333333
```

The *BinomCI* function in the *DescTools* package has several methods for calculating confidence intervals for a binomial proportion.

```
library(DescTools)

BinomCI(7, 21,
        conf.level = 0.95,
        method = "clopper-pearson")

        ###  Methods: "wilson", "wald", "agresti-coull", "jeffreys",
        ###  "modified wilson", "modified jeffreys",
        ###  "clopper-pearson", "arcsine", "logit", "witting", "pratt"

              est    lwr.ci    upr.ci
    [1,] 0.3333333 0.1458769 0.5696755
```

The *BinomCI* function in the *DescTools* package can also produce the confidence intervals for "success" and "failure" in one step.

```
library(DescTools)

observed = c(7, 14)

total = sum(observed)

BinomCI(observed, total,
        conf.level = 0.95,
        method = "clopper-pearson")

        ###  Methods: "wilson", "wald", "agresti-coull", "jeffreys",
        ###  "modified wilson", "modified jeffreys",
        ###  "clopper-pearson", "arcsine", "logit", "witting", "pratt"

              est    lwr.ci    upr.ci
    [1,] 0.3333333 0.1458769 0.5696755
    [2,] 0.6666667 0.4303245 0.8541231
```

The *PropCIs* package has functions for calculating confidence intervals for a binomial proportion.

The *exactci* function uses the Clopper–Pearson exact method.

```
7/21

    [1] 0.3333333


library(PropCIs)

exactci(7, 21,
        conf.level=0.95)

    95 percent confidence interval:
     0.1458769 0.5696755
```

The *blakerci* function uses the Blaker exact method.

```
7/21
```

```
[1] 0.3333333
```

```
library(PropCIs)

blakerci(7, 21,
         conf.level=0.95)
```

```
95 percent confidence interval:
 0.1523669 0.5510455
```

Example of confidence intervals for a multinomial proportion

As part of a demographic survey of her scrapbooking 4-H course, Seras Victoria asks students to report their sex. The following are the data from her course:

Sex	Count
Female	10
Male	9
Other	1
No answer	1
Total	21

```
library(DescTools)

observed = c(10, 9, 1, 1)

MultinomCI(observed,
           conf.level=0.95,
           method="sisonglaz")

### Methods: "sisonglaz", "cplus1", "goodman"
```

```
                est    lwr.ci    upr.ci
[1,] 0.47619048 0.2857143 0.7009460
[2,] 0.42857143 0.2380952 0.6533270
[3,] 0.04761905 0.0000000 0.2723746
[4,] 0.04761905 0.0000000 0.2723746
```

Optional analysis: confidence intervals for a difference in proportions

As part of a demographic survey of their scrapbooking 4-H courses, Seras Victoria and Integra Hellsing ask students if they have experience in scrapbooking. They want to determine the difference of proportions of students having experience in each class, and calculate a confidence interval for that difference. The following are the data:

Seras Victoria

Experience	Count
Yes	7
No	14
Total	21

Integra Hellsing

Experience	Count
Yes	13
No	4
Total	17

Two functions in the *PropCIs* package can determine a confidence interval for a difference for in independent proportions.

```
7/21
```

```
[1] 0.3333333
```

```
13/17
```

```
    [1] 0.7647059


(7/21) - (13/17)

    [1] -0.4313725


library(PropCIs)

diffscoreci(7, 21, 13, 17,
            conf.level=0.95)

    95 percent confidence interval:
     -0.6685985 -0.1103804


wald2ci(7, 21, 13, 17,
        conf.level=0.95,
        adjust = "Wald")

   ###  adjust = "AC", "Wald"

    95 percent confidence interval:
     -0.7165199 -0.1462252

    sample estimates:
    [1] -0.4313725
```

References

"Confidence Limits" in Mangiafico, S.S. 2015a. *An R Companion for the Handbook of Biological Statistics*, version 1.09. rcompanion.org/rcompanion/c_04.html.

Citation

Mangiafico, S.S. 2016. Summary and Analysis of Extension Program Evaluation in R, version 1.19.10. rcompanion.org/handbook/. (Pdf version: rcompanion.org/documents/RHandbookProgramEvaluation.pdf.)
