# A small R library which computes measurement precision: A companion to "How many decimals?"

The exact computations to round descriptive statistics are found in the main text under Table 1. The equations are all simple; however, there are a lot of formulas to remember. To assist in rounding descriptive statistics, I have designed a small R library called MeasurementPrecision (no space and two capital letters) which resides on GitHub. To upload it, first install the devtools library from CRAN (Wickham, Hester & Chang, 2019). Then prior to the first use, issue the commands

devtools::install\_github("dcousin3/MeasurementPrecision")

library(MeasurementPrecision)

On subsequent sessions, you can only use

library(MeasurementPrecision)

Let's assume the following two sets of observations

sample1 <- c(83, 58, 79, 50, 49, 53, 62, 79, 66)

sample2 <- c(71, 62, 83, 93, 56, 82, 66, 69, 82, 86, 74, 61, 59, 101, 94, 86, 75)

To get a rounded descriptive statistic, use a command named roundMP.*statistic*. For example, to round the mean of the first sample, use:

roundMP.mean(fromData = sample1, deltax=0.5)

where deltax, a mandatory argument, is the precision of the instrument. The command returns a one-line data frame with four columns:

# machine.precision extrinsic systematic non.systematic

# 64.33333 64 64.3 64.3

where machine.precision is the unrounded result, extrinsic is the extrinsic precision-based rounding; systematic is the result assuming systematic measurement error and non.systematic is the result assuming non-systematic measurement error.

In any of the commands, you can use fromData if you want to specify raw data or fromStatistics to provide already-calculated descriptive statistics (provide them with all the precision you can). For example,

roundMP.mean(fromStatistics = list(mean = 64.333333, sd = 13.20982, n = 9), deltax = 0.5)

returns the same results as above. If you issue this command with an empty list of statistics, an error message will let you know which statistics are required.

You can also round the standard deviation (sd), the standard error of the mean (semean) and the confidence interval of the mean (cimean):

roundMP.sd(fromData =sample1, deltax=0.5)

roundMP.semean(fromData =sample1, deltax=0.5)

roundMP.cimean(fromData =sample1, deltax=0.5)

In roundMP.cimean, add gamma = for a different coverage. For example, gamma = 0.80 will round a 80% confidence interval of the mean.

A one-sample *t*-test requires the null hypothesis for the mean, provided with mu0, for example:

roundMP.t.test(fromData =sample2, mu0=65, deltax=0.5)

where 65 kg is the average planetary body weight for humans.

For statistics on two independent samples, you can use

roundMP.meandiff(fromData = list(sample2, sample1), deltax=0.5)

roundMP.sdpool(fromData = list(sample2, sample1), deltax=0.5)

roundMP.cohen.d(fromData = list(sample2, sample1), deltax=0.5)

The argument fromData accepts vectors, matrices, data frames or a list of vectors (as illustrated here).

The non-systematic estimates are by default obtained from the simplifying assumptions described in Appendix B of the main paper. To use the full expression (non-parametric solution), add assumptions=FALSE to any of the commands, for example

roundMP.t.test(fromData = list(sample2, sample1), deltax=0.5, assumptions=FALSE)

Generally, there is not much differences whether the simplified or the full expression are used.

Finally, to obtain more details on the computations, and see the exact precision, you can add the option verbose=TRUE to any command. For example,

roundMP.mean(fromData = list(sample1), deltax=0.5, verbose=TRUE)

returns

----------------------------------------------------------------------

mean of input is: 64.33333

delta\_x of instrument is: 0.5

EXTRINSINC PRECISION: (result based on standard error of the mean)

- precision for mean is: 4.403282

- rounded mean of input is: 64

SYSTEMATIC ERROR INTRINSINC PRECISION: (result assumption-free)

- precision for mean is: 0.50005

- rounded mean of input is: 64.3

NON-SYSTEMATIC ERROR INTRINSINC PRECISION: (result assumption-free)

- precision for mean is: 0.1666833

- rounded mean of input is: 64.3

----------------------------------------------------------------------

machine.precision extrinsic systematic non.systematic

1 64.33333 64 64.3 64.3

The last two lines are identical to the solution provided earlier, but detailed information returns the precision for each scenario, whether a simplifying assumption was used, and the resulting rounded result.