

ACB spreadsheet verification: bias estimate from reference materials

Ed Wilkes

This document describes the verification of the bias estimates from reference materials spreadsheet, written by Prof Anders Kallner, that performs calculations for the assessment of bias between a given material and reference materials (July 2018 version). Calculations performed by these spreadsheets were verified in an independent statistical software (the R statistical computing environment v3.4.1) by the author of this document. The R packages required to run this code are shown below. This code can be copied and pasted into an instance of R and, given the test data as input, reproduce the analysis in this document.

Required packages:

```
require(dplyr)
require(knitr)
require(reshape2)
```

Reading data into R:

```
# Read in csv file: "2018-07 Trueness (bias) from reference materials -
test data.csv"
df <- read.csv(file.choose(), header = TRUE)
kable(df)
```

sample	value_1	value_2
1	37	38
2	39	37
3	36	36
4	39	38
5	38	37

Check calculation of means, SD, SEM, bias, and ranges:

The verification range can be defined as below, where $k = 2$ (or is derived empirically from the t -distribution), and u represents the uncertainty of the mean (i.e., SEM). These values are shown in cells I10:I19 and T10:T19.

$$\text{Verification range (MD)} = k \cdot \sqrt{u_{\text{target}}^2 + u_{\text{measured}}^2}$$

```
target_value <- 40
target_cv <- 5
target_u <- 40 * (5 / 100)
```

```

df %>% melt(id.vars = "sample") %>%
  summarise(mean = mean(value)
            , n = n()
            , sd = sd(value)
            , sem = sd(value) / sqrt(n)
            , bias = mean - target_value
            , interval = 2 * sqrt((target_u ^ 2) + (sem ^ 2)) # use k = 2
            , interval_low = mean - interval
            , interval_high = mean + interval
            , k_t_dist = qt(p = 0.975, df = n - 1) # derive k empirically
from t-distribution
            , t_interval = k_t_dist * sqrt((target_u ^ 2) + (sem ^ 2))
            , t_interval_low = mean - t_interval
            , t_interval_high = mean + t_interval
  ) %>%
  kable

```

me an	n	sd	sem	bi as	interv al	interval_ low	interval_ high	k_t_d ist	t_inter val	t_interval_ _low	t_interval_ _high
37.1	50	1.080	0.341	-2.5	4.057	33.44209	41.55791	2.262	4.5898	32.91018	42.08982
		123	565	2.5	914			157	2		

The mean, SD, SEM, bias, and verification range values match those calculated in the spreadsheet.

Conclusions:

1. Calculations of mean, SD, SEM, bias, and verification range matched the values in the spreadsheet