Cronbachs alpha estimation

Cronbach's alpha estimation with R

Explanations of the Sections:

- **Bonett-Formula**: Provides a mathematical way to estimate the required sample size based on desired Cronbach's Alpha, test power, confidence level, and the number of items in the test.
- **presize package**: provides a quick way in R to calculate the required sample size of cronbachs alpha based on a different approach.
- **R-code**: Shows how to implement the sample size calculation using the Bonett (2002) method, as well as an alternative using the `presize` package.

Via the Bonett-Formula

The required sample size N for Cronbach's Alpha can be calculated using the **Bonett-Formula** (Bonett 2002)

$$N = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \cdot (1 - \alpha) \cdot k}{\alpha}$$

Explanations:

- N : Required sample size
- α: Desired Cronbach's Alpha (e.g., 0.7 or 0.8)
- $Z_{\alpha/2}$: The critical Z-value for the confidence level (e.g., for a 95% confidence interval, the value is 1.96)
- Z_{β}: The critical Z-value for the test power (e.g., for 80% power, the value is 0.84)
- k: Number of items in the test (e.g., 10 items)

The formula calculates the minimum sample size required to achieve a desired Cronbach's Alpha with a given test power and confidence level.

Code example

```
# Input parameters
alpha1 <- 0.8     # Expected Cronbach's Alpha
alpha0 <- 0.70    # Minimum value (null hypothesis)
k <- 23           # Number of items
alpha <- 0.05     # Significance level
power <- 0.80     # Desired power

# Z-values
z_alpha <- qnorm(1 - alpha / 2)
z_beta <- qnorm(power)

# Calculation of required sample size according to Bonett (2002)
log_term <- log((1 - alpha0) / (1 - alpha1))
numerator <- (z_alpha + z_beta)^2
denominator <- log_term^2
multiplier <- (2 * (k - 1) / k)^2

n <- ceiling(numerator / denominator * multiplier)

cat("Required sample size:", n, "\n")
```

```
Required sample size: 175
```

via the `presize` - package (Haynes et al. 2021)

code example

```
#install.packages("presize")

library(presize)
```

```
Warning: Paket 'presize' wurde unter R Version 4.4.3 erstellt
```

```
prec_cronb(k = 23, calpha = 0.8, n = NULL, conf.level = 0.95, conf.width = 0.1)
```

```
     sample size for Cronbach's alpha

  calpha  k   n conf.width conf.level       lwr      upr
1    0.8 23 132        0.1       0.95 0.7452753 0.845356
```

Explanations:

- N: Required sample size
- *calpha*: expected Cronbach's Alpha (e.g., 0.7 or 0.8)
- $conf.level$: confidence level
- $conf.width$: precision (the full width of the confidence interval). is 0.84)
- k: Number of items in the test (e.g., 10 items)

References

Bonett, Douglas G. 2002. "Sample Size Requirements for Testing and Estimating Coefficient Alpha." *Journal of Educational and Behavioral Statistics* 27 (4): 335–40. https://doi.org/10.3102/10769986027004335.

Haynes, Alan G., Armando Lenz, Odile Stalder, and Andreas Limacher. 2021. "'Presize': An r-Package for Precision-Based Sample Size Calculation in Clinical Research" 6: 3118. https://doi.org/10.21105/joss.03118.