Bootstrapping

If you have a limited amount of data from which to obtain estimates of statistics for a population you may wish to consider bootstrapping. The sampling distribution for those estimates can be approximated by drawing new samples from the original data and then computing statistics from each sample obtained.

Bootstrapping is often used as an alternative to inferences based on parametric assumptions when those assumptions are in doubt, or where parametric inference is impossible (lack of normality, inadequate sample size, large variances, etc.) or requires very complicated formulas to obtain standard errors.

An advantage of bootstrapping is its simplicity. It is straightforward to derive estimates of standard errors and confidence intervals for complex estimators of complex parameters of the distribution, such as percentile points, proportions, odds ratio, and correlation coefficients. It is also an appropriate way to control and check the stability of the results.

Because bootstrapping is (under some conditions) asymptotically consistent, it does not provide general finite-sample guarantees. Furthermore, the results can be *overly optimistic*. The apparent simplicity may conceal the fact that important assumptions are being made when undertaking the bootstrap analysis (e.g. independence of samples) where these would be more formally stated in other approaches. Bootstrapping is a way of testing the reliability of the dataset.

Adèr et al.(2008) recommend the bootstrap procedure for the following situations:

1. When the theoretical distribution of a statistic of interest is complicated or unknown. Since the bootstrapping procedure is distribution-independent it provides an indirect method to assess the properties of the distribution underlying the sample and the parameters of interest that are derived from this distribution.
2. When the sample size is insufficient for straightforward statistical inference. If the underlying distribution is well-known, bootstrapping provides a way to account for the distortions caused by the specific sample that may not be fully representative of the population.
3. When power calculations have to be performed, and a small pilot sample is available. Most power and sample size calculations are heavily dependent on the standard deviation of the statistic of interest. If the estimate used is incorrect, the required sample size will also be wrong. One method to get an impression of the variation of the statistic is to use a small pilot sample and perform bootstrapping on it to get impression of the variance.

To see an example of bootstrapping check out:
http://reference.wolfram.com/mathematica/howto/PerformABootstrapAnalysis.html

Reference:

Adèr, H. J., Mellenbergh G. J., & Hand, D. J. (2008). *Advising on research methods: A consultant's companion*. Huizen, The Netherlands: Johannes van Kessel Publishing. ISBN 978-90-79418-01-5