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Bootstrap method and its application to the hypothesis testing in GPS mixed integer linear model

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High accuracy GPS relative positioning is usually based on the double-differenced (DD) carrier phase observables. When considering short baseline (less than 20 km), the linear model for DD phase may be simplified to a mixed integer linear model, where the central problem of the determination of the integer phase ambiguities must be first solved. This topic has therefore been a rich source of GPS geodesy research over the last decades and more than 300 papers related to the method and application are published. Until now most of the existed validation and hypothesis tests (e.g. 2-test, F-test, t-test, and ratio test etc.) about the float solution and the fixed solution within Least Squares Ambiguity Search (LSAS) or "Integer Least Squares" approaches are performed under the assumption that the measured phases or phase differences are approxi-mately Gauss-Laplace normally distributed. But based on our new research results (Cai, et al., 2007), the GPS carrier phase observables that are actually measured on the unit circle have been statistically validated to have a von Mises normal distribution. The existed validation and hypothesis testing procedures should therefore be improved accordingly. Since the distributions of the statistics commonly used for inference on directional distributions are more complex than those arising in standard normal theory, bootstrap methods are particularly useful in the directional context. As one of the modern statistical techniques since 1980s bootstrap method refers to a class of computer-intensive statistical procedures, which can often be helpful for carrying out a statistical test of a point estimate in situations where more usual statistical procedures are not valid and /or not available (e.g. the sampling distribution of a statistic is not known). In the linear model context, these bootstrap methods provide inference procedures (e.g. confidence sets) that are asymptotically more accurate than those produced by the other methods. This is just the case for the validation and hypothesis tests of the float and fixed estimates of GPS mixed models in the directional context, with the emphasis on the determination of the confidence intervals of the estimates. Here we will review the technological and methodological aspects of the bootstrap methods, and apply two bootstrap analysis methods for linear model, bootstrapping residuals and bootstrapping pairs, to the confidence domains/hypothesis tests on the parameters of the GPS mixed integer linear models.