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Some Examples of Imperfect Mathematical Modeling in Geodesy

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The past six decades have witnessed a fascinating progress of geodetic instrumentation and a development of new observation techniques. The same holds for the progress of the computing hardware, reaching computational speeds and data storage capacities which were unimaginable in the past. These processes were accompanied by remarkable advances in mathematical modeling and numerical methods for data analysis and solving geodetic problems.

However, recent literature contains examples for unnecessary mathematical approximations, pitfalls and avoiding of computationally intensive methods, too. Textbooks on Surveying contain approximate expressions which were useful in pre-computer era, and at that time accurate enough for the achievable accuracy of observations. However, such expressions sometimes lead to wrong interpretations and show no advantages nowadays. An L1-norm adjustment is in contemporary geodetic literature usually still emulated by iteratively re-weighted least squares, which might diverge or converge to an incorrect value, although there are no reasons any more to avoid methods of linear programming. Several algorithms for geodetic applications based on Total least squares (TLS) have been published in recent years which yield incorrect results, or at least the examples illustrating the algorithms have been computed incorrectly. Application of global optimization methods is still avoided as far as possible, although they are practicable with the capacities of contemporary computers. For instance, even in cases where it can be expected that the data contain sinusoidal variations of arbitrary frequencies, a model based on Fourier-like frequencies, postulated in advance, is preferred, since it requires only local optimization techniques. Some of the problems listed above are illustrated on examples.