

Index determination of DAEs - a wide field for Automatic Differentiation

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Many numerical methods solving ODEs need derivatives. Implicit methods need Jacobian matrices or the result of a method depends on derivatives of given functions as we will see later on.

In contrast to the classical finite difference method the method of automatic differentiation (AD) is numerically stable and accurate, and is available for many platforms like C/C++, Fortran, matlab, and python.

The index of a Differential-Algebraic equation (DAE) indicates the expected difficulties when solving this DAE.

The tractability index concept, which bases on the linearization of the DAE along a given function determines the index by checking the nonsingularity of a matrix computed over a matrix sequence.

The matrix we have to check is computed using the Jacobians of the DAE and a matrix sequence that contains a differentiation itself. It results that the index of a DAE may depend of the derivative of the function along which the linearization proceeds.

The index determination using AD is discussed, comparisons with other index definitions and illustrative examples are given.