On the Extension of Adams–Bashforth–Moulton Methods for Numerical Integration of Delay Differential Equations and Application to the Moon's Orbit

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Abstract. One of the problems arising in modern celestial mechanics is the need of precise numerical calculation of the Moon's orbit. Due to the nature of tidal forces, their action is modeled with a time delay and the orbit is therefore described by a so-called delay differential equation (DDE). Numerical integration of the orbit is normally being performed in both directions (forwards and backwards in time) from some epoch, and while the theory of normal forward-in-time numerical integration of DDEs is developed and well-known, integrating a DDE backwards in time is equivalent to solving a special kind of DDE called an advanced-delay differential equation, where the derivative of the function depends on not yet known future states of the function, which presents a certain numerical challenge.

The present work examines a modification of Adams–Bashforth–Moulton method allowing to perform integration of the Moon's DDE forwards and backwards in time and the results of such integration.

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