Effective order Runge–Kutta methods with free output

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The concept of effective order was introduced in 1969. It makes it possible to reduce the number of order conditions for explicit Runge–Kutta methods considerably; for example, for p=5, from 17 to 10. In particular, it is possible to construct methods of effective order five with only five stages. It might be asked why efficient codes based on these methods are not available and widely used. One possible reason is that a finishing method, with additional cost, is needed whenever an output of the solution needs to be computed.

In this talk we will show that it is possible to construct methods for which essentially free output is available at the end of any step. This is achieved by re-using the stage values of the main method to provide an in-built finishing method. The main tool for this investigation is the composition of B-series.