

# Comparison of Runge-Kutta Methods of Order 4 and 5 on Lorenz Equation

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February 4, 2005

## Abstract

An explicit MATLAB algorithm for the implementation of Runge-Kutta method of orders 4 and 5 is given. The running time and maximum errors for the two methods are compared on Lorenz equation

**Keywords:** Runge-Kutta, Lorenz, Numerical Solution, System of ODE

## 1 Introduction

Systems of ordinary differential equations are very common in many applied sciences and engineering problems as well as within mathematics itself. Unfortunately, most of these equations are nonlinear whereas most of the methods of solution are linear. This leaves numerical methods of solution the only possibility in many cases.

The method of Runge-Kutta is one of the well-known numerical methods for differential equations. The common versions are order 4 and order 5. In this paper, we have written a MATLAB routine that applies this method to any system of differential equation, in any dimensions, and finds solutions satisfying a give error bound.

The advantage of using such an explicit m-file rather than MATLAB's built-in solvers like ode45 [?] is that we have greater control in the inner workings of the program. We can specify the step size, maximum error level, time limit etc. We can start with more than one initial points and plot the result. Also, the algorithm is more pedagogical and may be used to illustrate the method of Runge-Kutta for numerical analysis students.

## 2 Runge-Kutta Methods of Order 4 and 5

Consider the system of ordinary differential equations