Picard's Method Encyclopedia Article

Picard's Method

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Picard's Method

Picard's method, sometimes called the method of successive approximations, gives a means of proving the existence of solutions to **differential equations**. Emile Picard, a French mathematician, developed the method in the early 20th century. It has proven to be so powerful that it has replaced the Cauchy-Lipschitz method that was previously employed for such endeavors.

Picard developed his method while he was a professor at the University of Paris. It arose out of a study involving the Picard-Lindelof existence **theorem** that had been formulated at the end of the 19th century. Picard's method is utilized in similar situations as those that employ the Taylor series method. It is a method that converts the differential equation into an equation involving integrals.

Some differential **equations** are difficult to solve, but Picard's method provides a numerical process by which a solution can be approximated. The method consists of constructing a sequence of **functions** that will approach the desired solution upon successive **iteration**. It is similar to the Taylor series method in that successive iterations also approach the desired solution to a differential equation. Picard's method allows us to find a series solution about some fixed point. The number of terms or iterations that is required to reach the desired solution depends on how far from the chosen point the solution must apply. The closer the chosen point to the unknown point, the fewer terms that are needed. It can be shown that the series is convergent and provides a solution to the differential equation of interest although the number of terms will depend upon how rapidly the series converges as well.

The details of Picard's method involve starting with an initial value problem and expressing it as an integral equation. This is done by integrating both sides with respect to one **variable** from a defined starting point to a defined termination point, x_0 to x_1. The initial value given is substituted into the resulting integral equation. This yields the function evaluated at the initial value summed with the remaining integral. After a simple substitution and appropriate arrangements of the **limits** on the remaining integral, the result can be used to generate successive approximations of a solution to the initial equation. The number of iteration steps is determined by two factors: how quickly the series converges and how far away from the point of interest is the value given in the initial problem.