

# Analysis of Root Methods: Bisection, Secant, and Riddler's

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Root finding methods are an integral part of numerical analysis in scientific fields, as hand calculations are too long and tedious, especially for larger more complicated problems. Iterative in nature, the discussed methods will be the Bisection method, the Secant method, and the Riddler's method. The results of approximating the results of the following function will be compared.

$$x \sin 10x - x = -1 \tag{1}$$

The Bisection method simply takes two initial guesses that have to span a root in the function. In our case the initial roots 0.6 and 1.2 will be used which do span a root in Equation 1. It then finds a guess directly between the initial guesses, evaluates the function at that point, and then uses that, and one of the initial roots whose value is the opposite sign to create two new roots. This process is repeated until the difference between the new and old guesses is sufficiently small. This method is inferior to the other two because it takes many more iterations to get to the root. The differences have been tabulated in Table 1 and it can be seen that the Secant and Riddler's methods arrive at the answer after 7 iterations while the Bisection takes around 20. The Secant and Riddler's methods are both very similar to the bisection method in iteration, but they calculate a new guess more accurately.

Figure 1 shows Equation 1 plotted from 0 to 3 with the location of the root in question marked. Figure 2 shows the difference in arrival at the solution for the three different methods showing that the Bisection method overshoot it and eventually settled, the Secant method oscillated just once, and

Table 1: Root guesses for each iteration for the methods in question

Iteration	Bisection Method		Secant Method		Riddler's Method	
	Root	Error	Root	Error	Root	Error
1	0.9000	3.33E-1	0.7295	6.45E-1	1.1186	4.64E-1
3	1.0500	1.43E-1	0.9191	5.64E-2	0.9477	6.49E-2
5	0.9375	4.00E-2	0.9479	5.74E-4	0.9479	1.37E-2
7	0.9469	9.90E-3	0.9479	7.06E-9	0.9479	3.43E-3
10	0.9480	1.24E-3	...	...	...	...
15	0.9479	3.86E-5	...	...	...	...
20	0.9479	2.41E-6	...	...	...	...

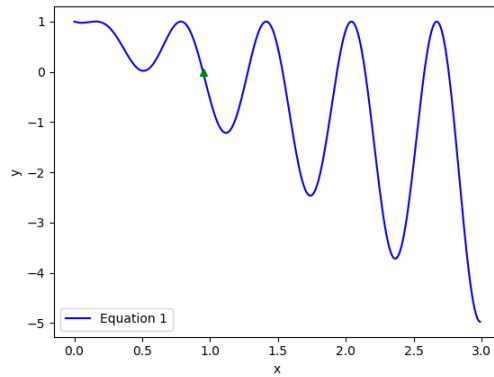


Figure 1: Equation 1 plotted from [0,3]

Riddler's method was very close for just the second guess. Riddler's method outperforms the other methods for this equation when iteratively finding the roots.

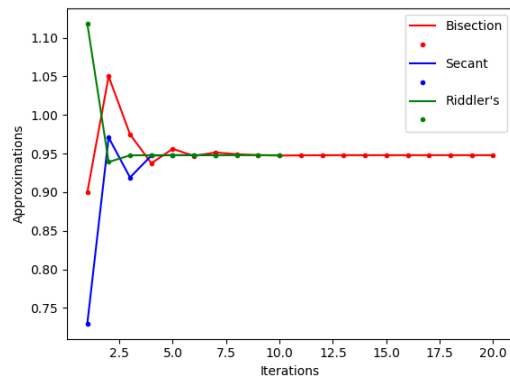


Figure 2: Root guesses for each method per iteration

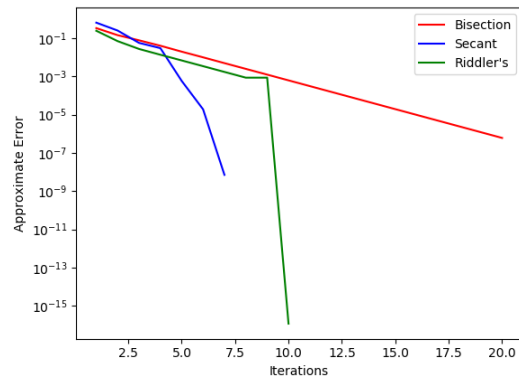


Figure 3: Error values for each method per iteration