

Numerical Analysis (The Bisection Method)

Introduction

The bisection method is simple, robust, and straight-forward: take an interval $[a, b]$ such that $f(a)$ and $f(b)$ have opposite signs, find the midpoint of $[a, b]$, and then decide whether the root lies on $[a, (a + b)/2]$ or $[(a + b)/2, b]$. Repeat until the interval is sufficiently small.

Background

Useful background for this topic includes:

- 3. Iteration
- 8. Bracketing

References

- [Bradis](#), Section 2.1, The Bisection Method, p.58.
- [Mathsas](#), Section 2.2, Bisection Method of Bolzano, p.53.
- [Weisstein](#), <http://mathworld.wolfram.com/Bisection.html>.

Theory

Intermediate Value Theorem (IVT)

Given a continuous real-valued function $f(x)$ defined on an interval $[a, b]$, then if y is a point between the values of $f(a)$ and $f(b)$, then there exists a point r such that $y = f(r)$.

As an example, consider the function $f(x) = \sin(x)$ defined on $[1, 6]$. The function is continuous on this interval, and the point 0.5 lies between the values of $\sin(1) = 0.841$ and $\sin(6) = -0.279$. Thus, there is at least one point r (there may be more) on the interval $[1, 6]$ such that $\sin(r) = 0.5$. In this case, $r = 2.61799$. This is shown in Figure 1.

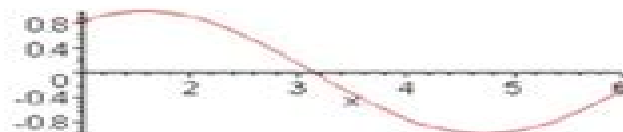


Figure 1. The IVT applied to $\sin(x)$ on $[1, 6]$ with $y = 0.5$.

Using the IVT to Bound a Root

Numerical Analysis Bsc Bisection Method Notes

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An Introduction to the Numerical Analysis of Spectral Methods Bertrand Mercier, 2014-08-23 This is a very lucid introduction to spectral methods emphasizing the mathematical aspects of the theory rather than the many applications in numerical analysis and the engineering sciences The first part is a fairly complete introduction to Fourier series while the second emphasizes polynomial expansion methods like Chebyshev s The author gives rigorous proofs of fundamental results related to one dimensional advection and diffusions equations The book addresses students as well as practitioners of numerical analysis

Afternotes Goes to Graduate School G. W. Stewart, 1998 Afternotes on Numerical Analysis is the result of the author writing down his notes immediately after giving each lecture

Topics in Numerical Analysis P. R Turner, 2014-01-15

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Continuous Method in Numerical Analysis Applied to Examples from a New Class of Boundry Value Problems H. Melvin Lieberstein, University of Wisconsin--Madison. Mathematics Research Center, Mathematics Research Center (United States. Army), 1960

Innovative Methods in Numerical Analysis Association internationale pour les mathématiques et calculateurs en simulation, 1994

Topic in Numerical Methods John H. Halton, 1982 **Numerical Analysis of Spectral Methods: Theory and Applicatons** D. Gottlieb, S. Orszag, 1986 **Numerical Analysis and Scientific Computing for Partial Differential Equations and Their Challenging Applications** Rolf Stenberg, Jacques Periaux, Pekka Neittaanmäki, Juha Haataja, Peter Råback, 2008

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