

## 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), <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.

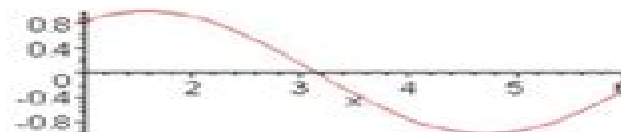


Figure 1. The IVT applied to  $\sin(x)$  on  $[1, 6]$  with  $y = 0.5$ .

#### Using the IVT to Bound a Root

# Numerical Analysis Bsc Bisection Method Notes

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Numerical Analysis of Spectral Methods David Gottlieb, Steven A. Orszag, 1977-01-01 A unified discussion of the formulation and analysis of special methods of mixed initial boundary value problems The focus is on the development of a new mathematical theory that explains why and how well spectral methods work Included are interesting extensions of the classical numerical analysis

**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

**Teapack Users' Manual** Robert L. Johnston, 1982-01-01

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 Applications* 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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