

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.
- [Mathews](#), 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.

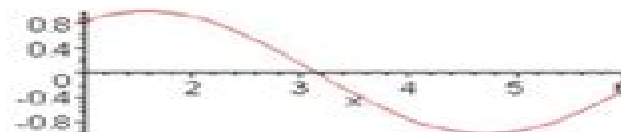


Figure 1. The IVT applied to $\sin(x)$ on $[1, 6]$ with $y = 0.5$.

Using the IVT to Bound a Root

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