

## 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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