

MARCH 10TH, 2025

# Root Finding

CE 311K - L25



# Root Finding

**Root finding** is the process of determining the values of  $x$  that satisfy the equation  $f(x)=0$

Root finding is a fundamental tool in engineering for solving equations that arise in various disciplines

**Structural Engineering:** Solving equilibrium equations for forces and moments

**Fluid Mechanics:** Finding flow rates

**Thermal Systems:** Solving for temperature distributions in heat transfer models

**Optimization:** Finding maxima and minima often involves solving finding where the derivative is equal to zero - a root-finding problem



# Root Finding Considerations

**Bracketing Methods:** Requires an interval over which the function changes sign

Function must be continuous over the interval

---

**Iterative Methods:** Start with an initial guess and improve the solution iteratively

Good initial guesses are required for convergence

---

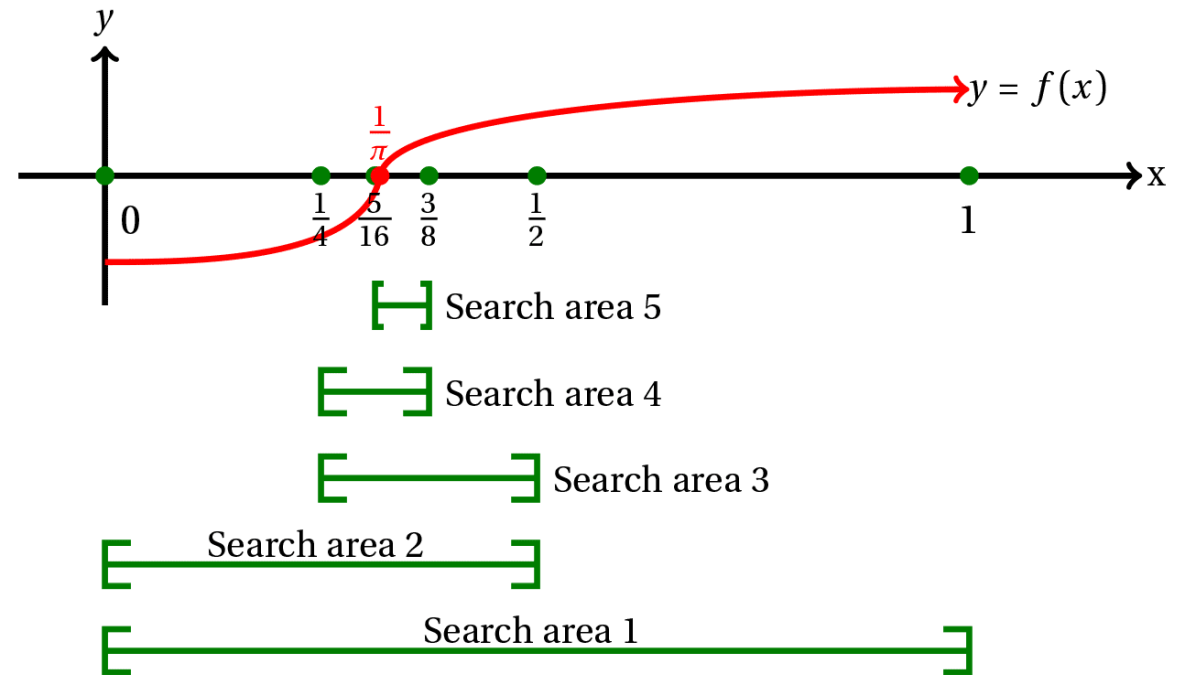
**Multiple Roots** can complicate the methods ability to correctly identify the root

# Bisection Method

The **Bisection Method** repeatedly halves the interval and selects the subinterval where the root lies

Bisection depends on the **Intermediate Value Theorem**:

$f(x)$  continuous on  $[a, b]$  and  $f(a) \cdot f(b) < 0$ , then  $c \in [a, b]$  such that  $f(x) = 0$



# Newton-Raphson

The **Newton-Raphson Method** iteratively refines an initial guess using the derivative of the original function

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

