CPE 310: Numerical Analysis for Engineers

Course Overview

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B.Eng. Computer Engineering
(Class of 2007)

IOWA STATE UNIVERSITY

M.Sc. Computer Engineering
(Class of 2011)

IOWA STATE UNIVERSITY

Ph.D.. Computer Engineering
(Class of 2016)

Secure Programming

Static Program Analysis

Data & Pattern Mining

Software Analysis & Security

Bug finding and Malware detection

Build System Analysis

Abstractions and Symbolic Evaluations

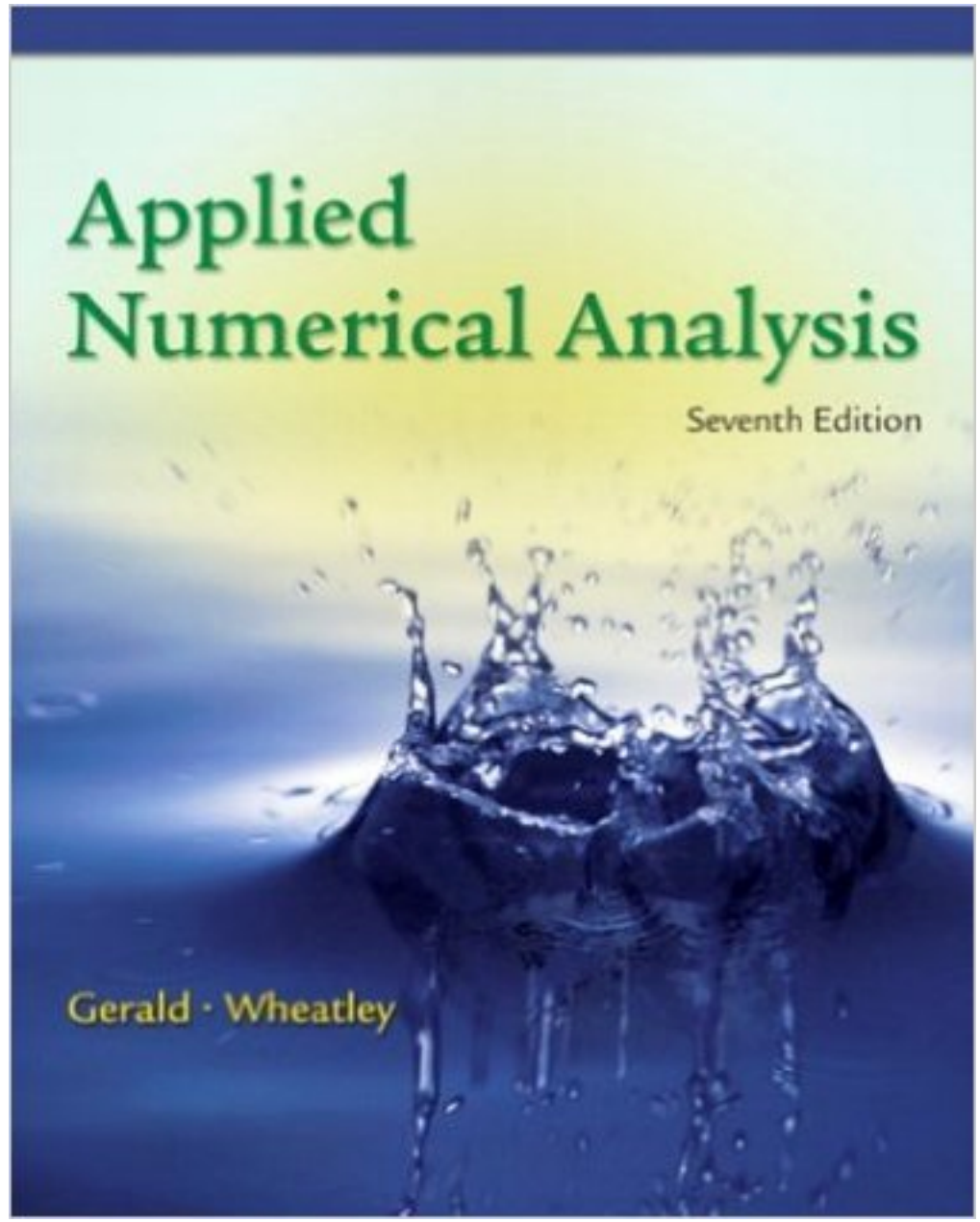
YOU

- *Name*
- *Year in undergraduate program.*
- *Something about you*
  - *Food you like.*
  - *Programming languages you used.*
  - *Open source projects you contributed to.*
- *What do you think of this course?*
- *What are your goals after graduation?*

Course Website

https://sites.google.com/site/cpe310spring2017/

Syllabus

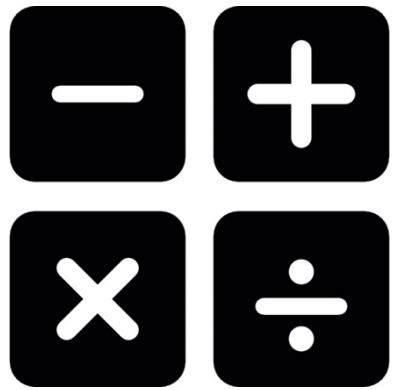

Applied
Numerical Analysis
Seventh Edition
Gerald · Wheatley

Goal of the Class

This is not a course to teach you to code

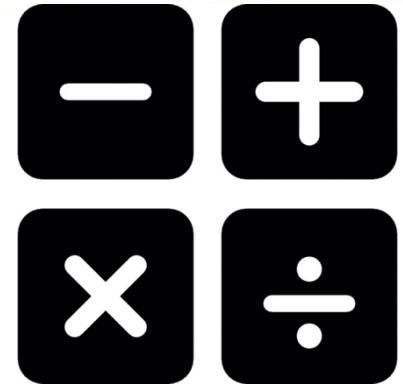
This is a course to teach you **computer algorithms** for analyzing and solving science and engineering problems in numerical ways

We will learn how a computer can be used to solve problems that **may not be solvable** by the techniques that are taught in most calculus courses




SPACED
OUT!
i don't bite, but he does!


1 2 3 4 5
6 7 8 9 10



Analysis in Mathematics

Solve a problem through equations. The equations must then be reduced to an answer through the procedures of algebra, calculus, differential equations, partial differential equations, or the like.

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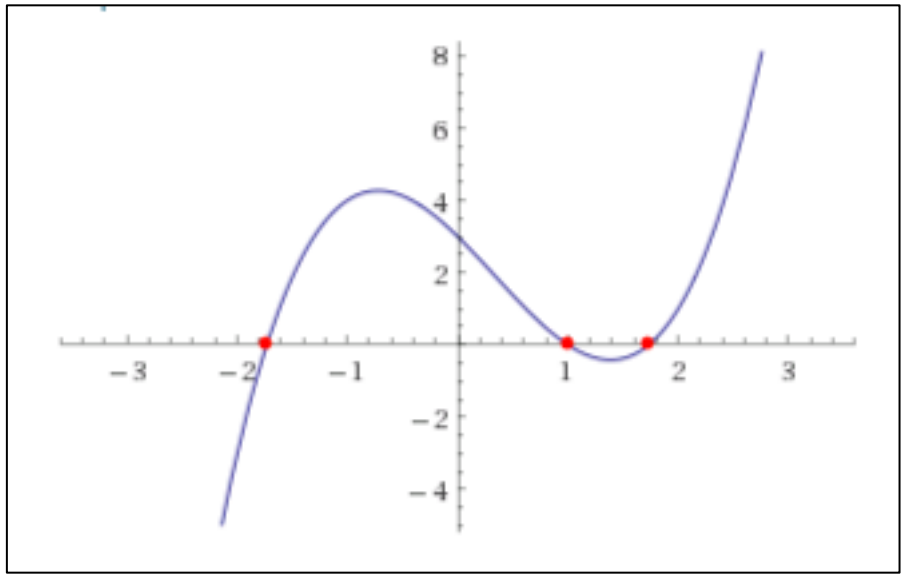
$$f(x) = x^3 - x^2 - 3x + 3$$



$$x^3 - x^2 - 3x + 3 = 0$$

$$(x^3 - x^2) + (-3x + 3) = 0$$

$$x^2(x - 1) - 3(x - 1) = 0$$

$$(x - 1)(x^2 - 3) = 0$$

$$x = 1, \pm\sqrt{3}$$

Numerical Analysis

The only procedures to solve the problem are arithmetic: add, subtract, multiply, divide, and compare. Since these operations are exactly those that computers can do

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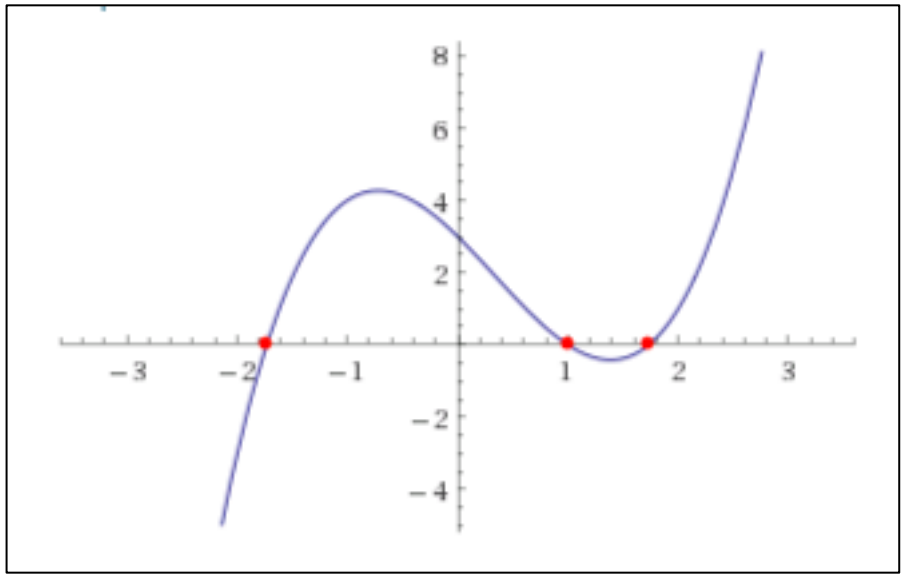
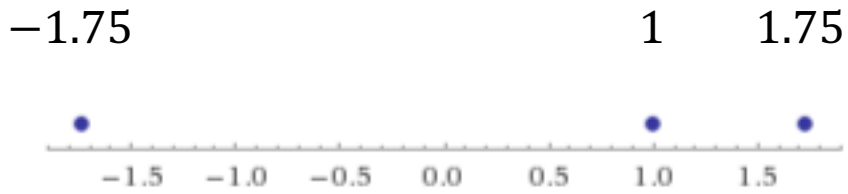
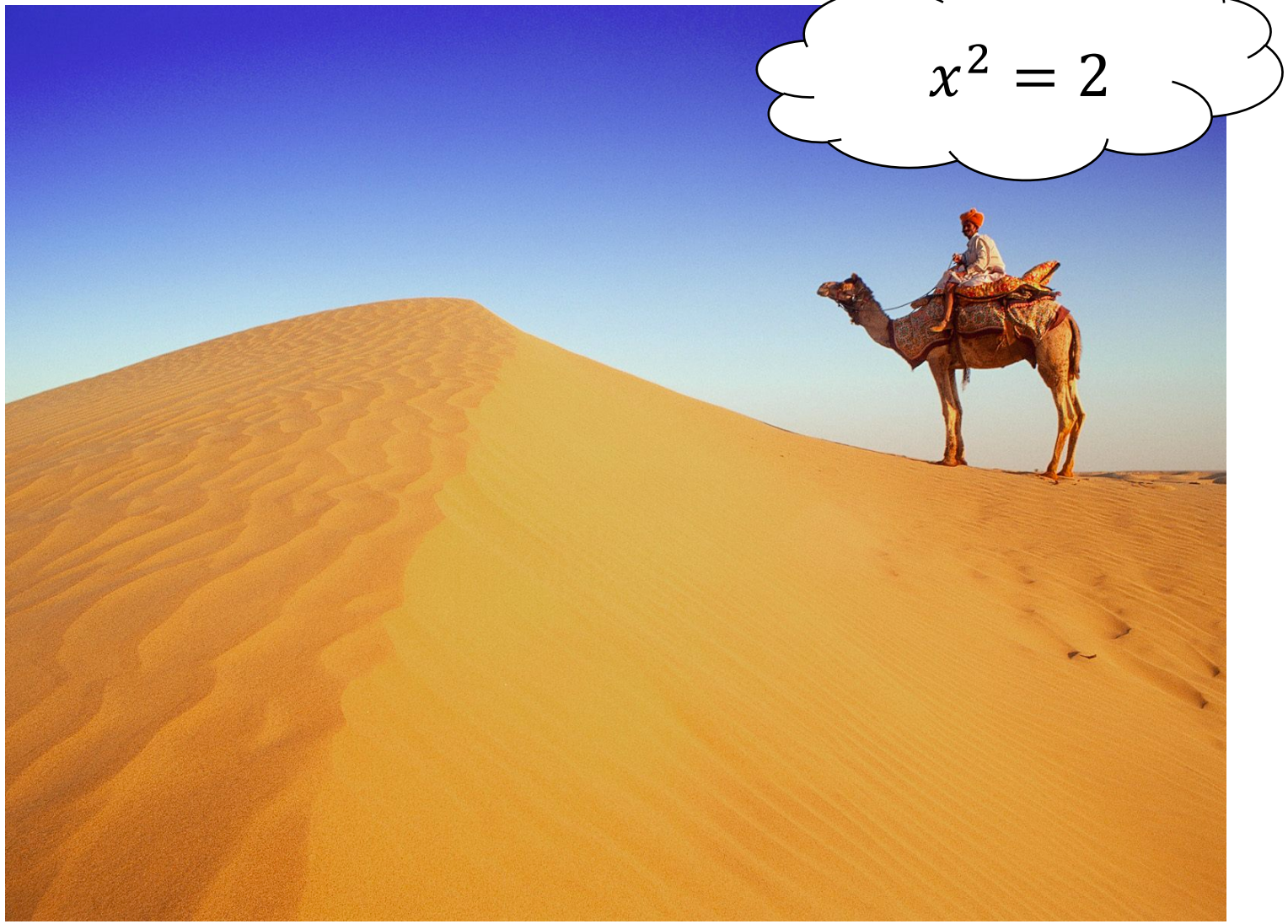




$$\sqrt{3} = 1.73205080757$$


$x^2 = 2$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What is x?

$$x = \sqrt{2}$$

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What is *x*?

$(1.5)^2 = 2.25$ *Too Large*

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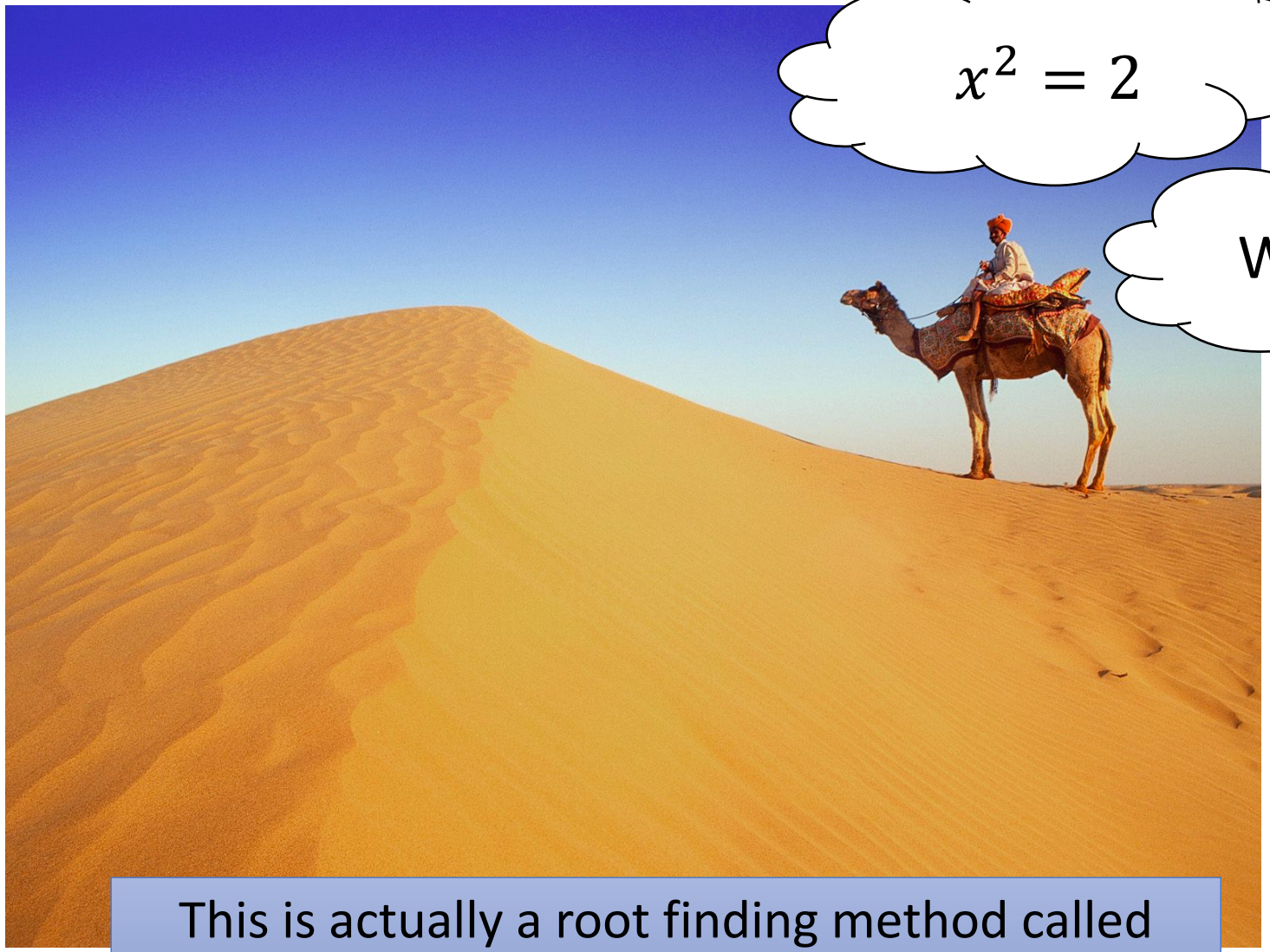
$$\sqrt{2} = 1.41421356237$$



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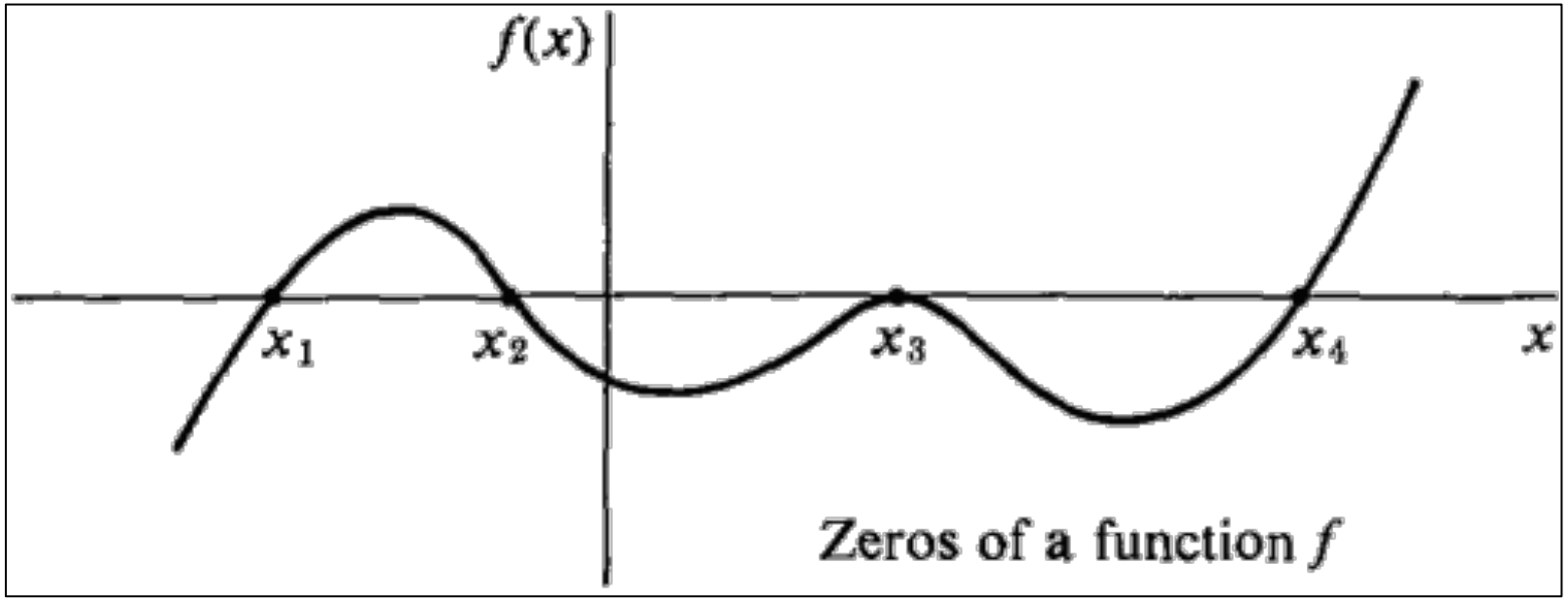
This is actually a root finding method called "Bisection"

$\sqrt{2} = 1.41421356237$

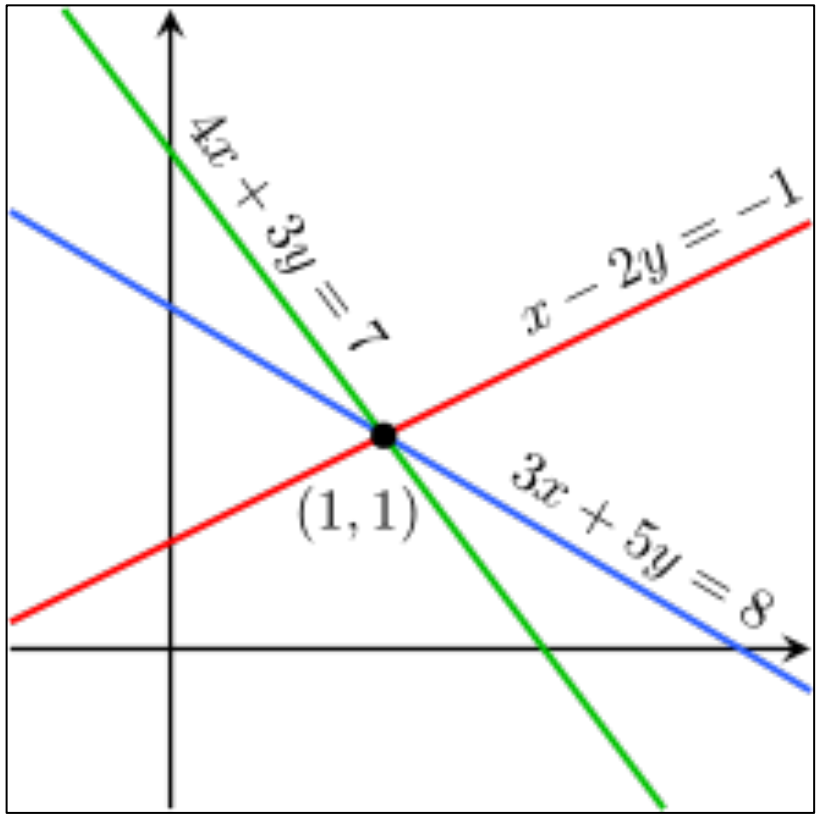
Accuracy, Approximation, and Error

Examines the important topic of the accuracy of computations and the different sources of errors. Errors that are due to the way that computers store numbers are examined in some detail

Solving Nonlinear Equations



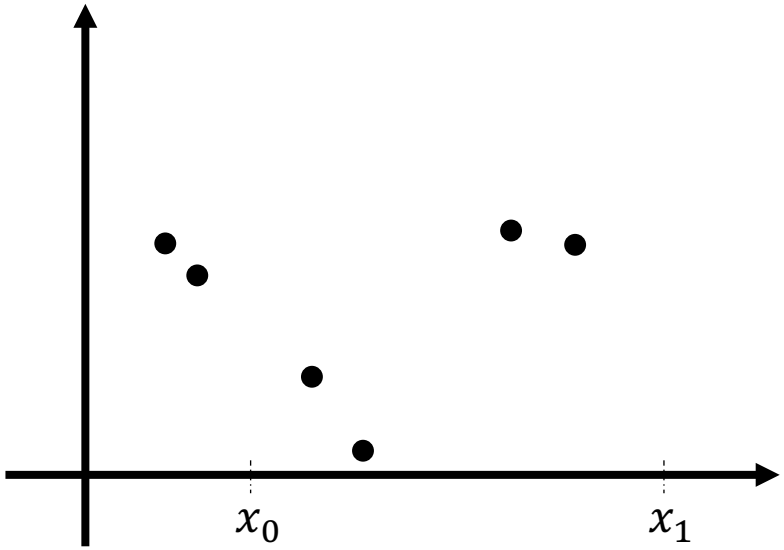
Solving Sets of Linear Equations



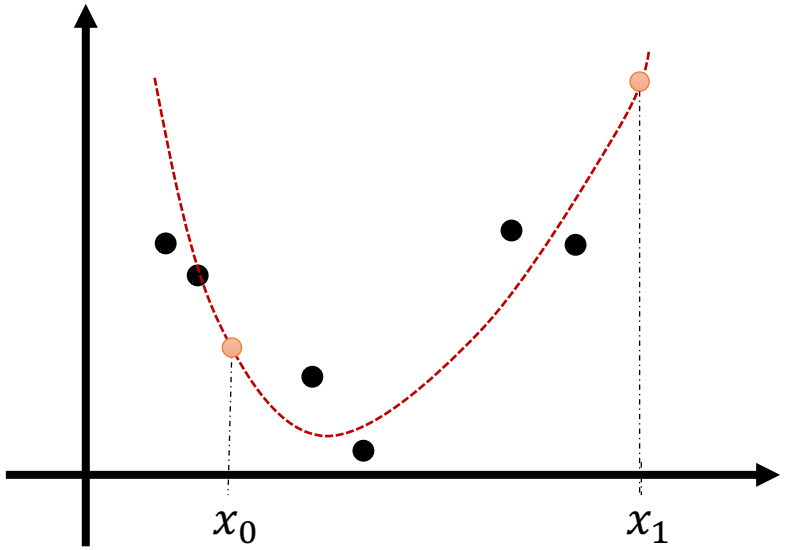
$$x - 2y = -1$$
$$4x + 3y = 7$$
$$3x + 5y = 8$$

Interpolation and Curve Fitting

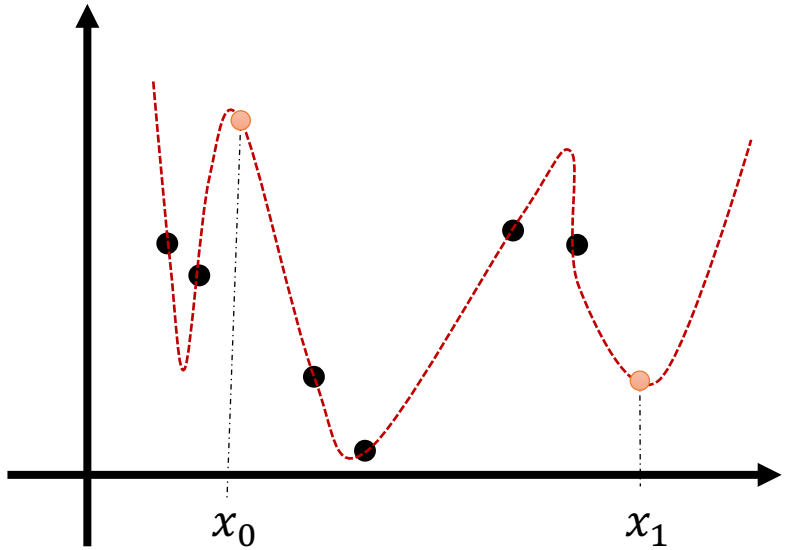
Curve Fitting is the process of constructing a curve, or mathematical function, that has the best fit to a series of data points



We would like to find intermediate or predicted values



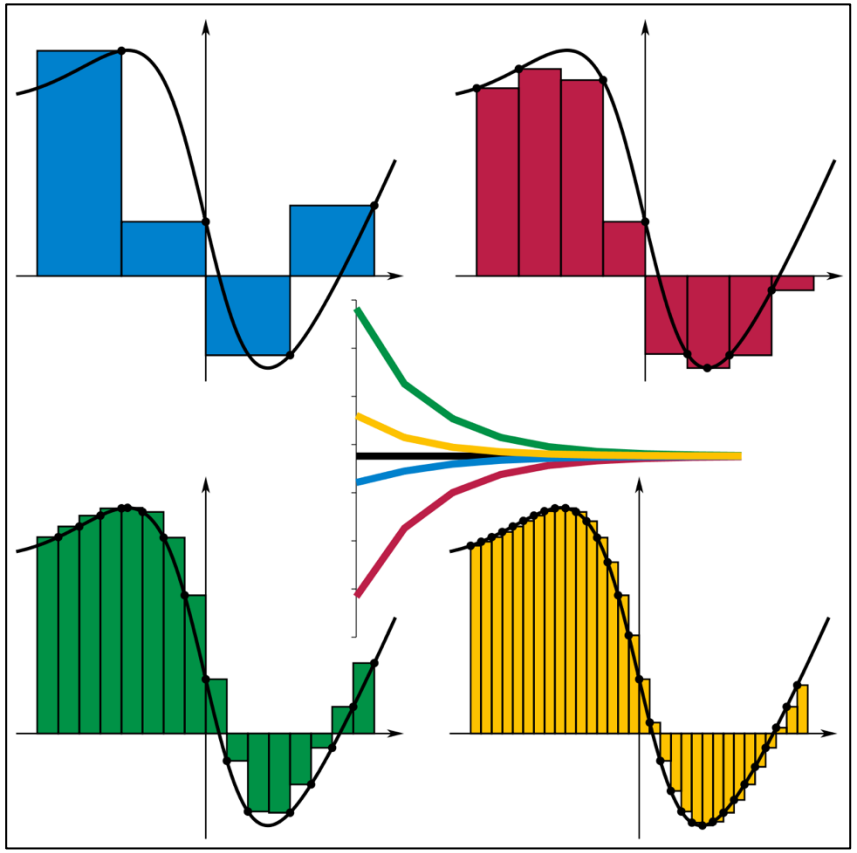
Fit Curves to Data Points



If the curve passes all data points, we call it interpolation

Numerical Differentiation & Integration

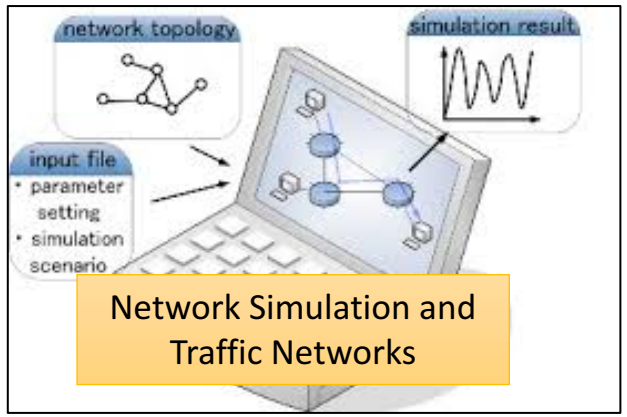
approximate derivative values of a function and approximate definite integral, even when no analytical form exists



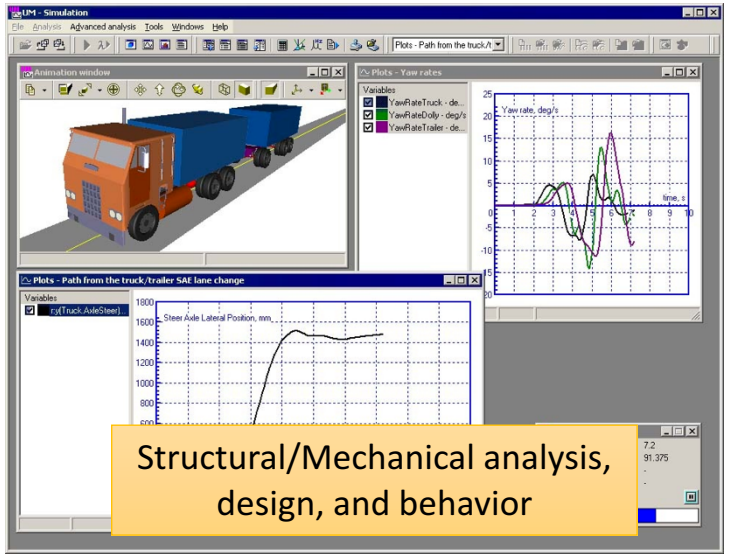
Solution of Ordinary Differential Equations

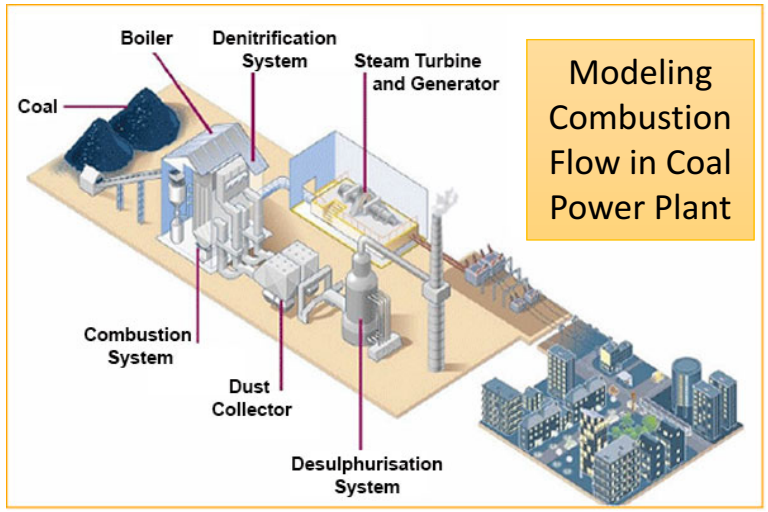
An ordinary differential equation (ODE) is a differential equation containing one or more functions of one independent variable and its derivatives.

Applications of Numerical Methods

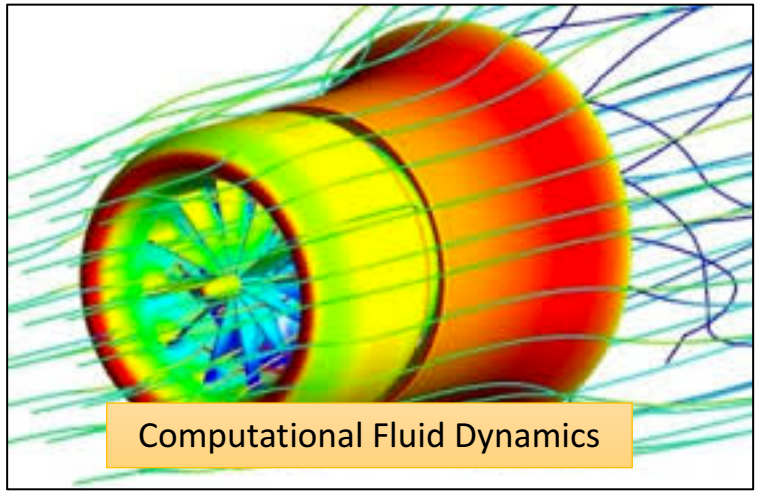


Network Simulation and Traffic Networks

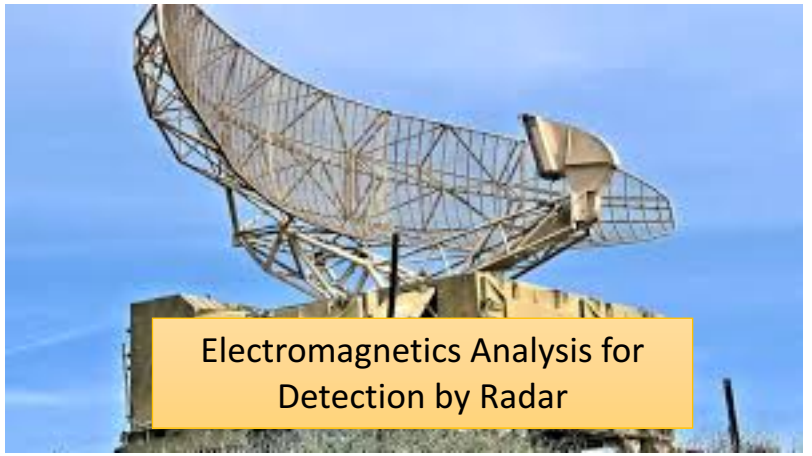

Structural/Mechanical analysis, design, and behavior

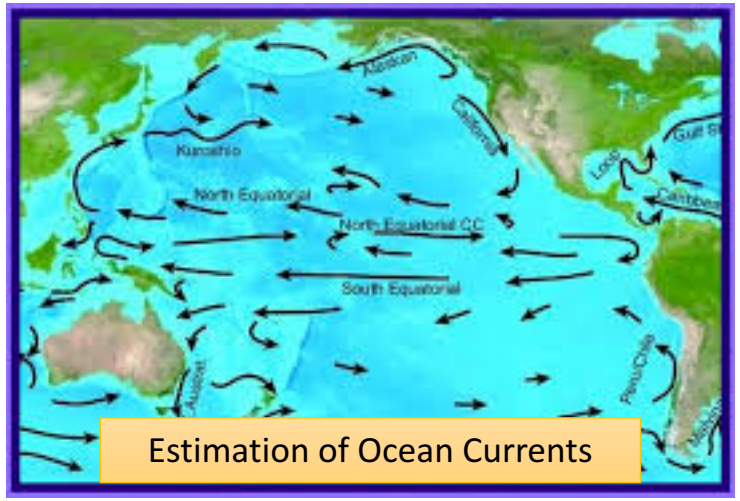


Modeling Combustion Flow in Coal Power Plant


Computational Fluid Dynamics

Weather Predictions


Electromagnetics Analysis for Detection by Radar



Estimation of Ocean Currents