Course Roadmap

Topic # 0 (Not really algorithms)

- How to represent real numbers in a computer?

- Errors in numerical calculations

  How to quantify errors?
  → Absolute errors
  → Relative errors

  What types of errors?
  → Truncation error
  → Round-off error

Topic #1 (Solving single nonlinear equation for real roots)

Solve $f(x) = 0$ for real x

- If $f(x)$ was linear, then no need for computational algorithms:

  example: $2x + 3 = 0 \Rightarrow x = -3/2$

But need computational algorithm for:

- $\underbrace{2x^5 - 5x^4 + 20x^3 - 10x^2 + 10x - 1 = 0}$

  4 complex conjugate roots, $\underline{1 \text{ real root}}$
  ↖ How to compute it?

- $\underbrace{cos(x) - x}_{f(x)} = 0 \Rightarrow x \underset{\text{↖ How to compute it?}}{\approx \underline{0.7391 \ldots}}$

Topic #2 (Solving a system of linear equations)

Example:

$$2x + 3y - 5z = 0$$
$$11.9x - 18y + 12z = 0$$
$$x - y - z = 0$$

want to solve for $\begin{pmatrix} x \\ y \\ z \end{pmatrix}$
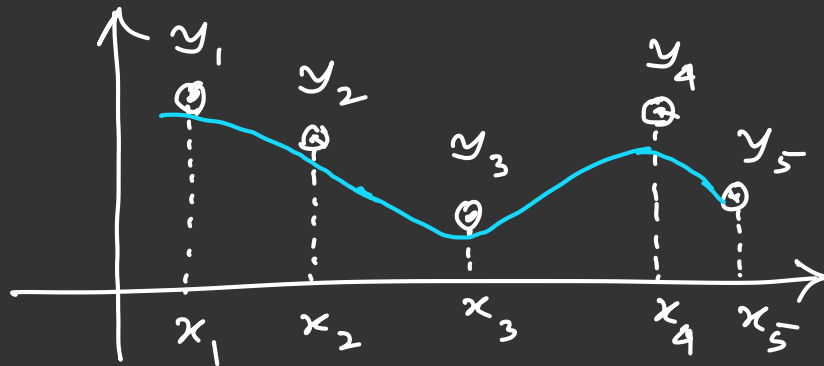
Equivalent to solving single matrix-vector equation:

$$\underset{3\times3}{A} \underset{3\times1}{x} = \underset{3\times1}{b}$$

Solve for the unknown vector $x = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$ with given matrix A and vector b

Topic # 3 (Function interpolation)
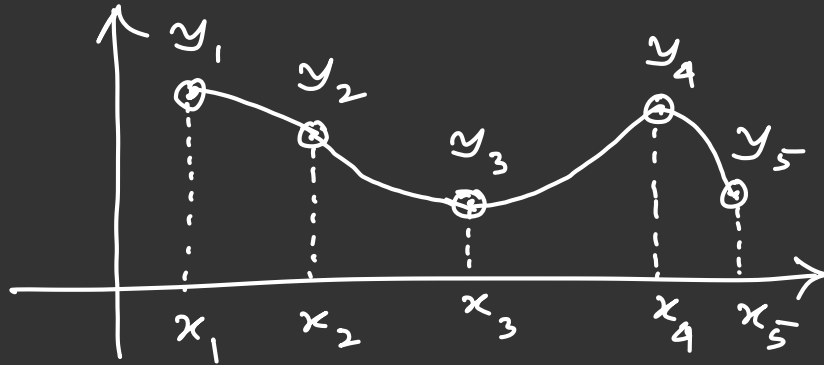
Topic # 4 (Function approximation/ Regression)

Topic #5 (Calculus on computer: Numerical differentiation and integration)

Topic #6 (Solving ordinary differential equation initial value problems)

Topic #7 (Matrix eigenvalue problems)

→ Compute largest/smallest magnitude eigenvalue of a large square matrix

→ Compute all eigenvalues of a square matrix