Lecture #15
03/15/2023

Course Summary

① MATLAB basics (Lec. 1 - 3)

② Numerical errors :

(Lec. 4 - 5)

→ Types → Truncation error
→ Round-off error

→ Ways to quantify → Absolute error
→ Relative error

③ Solving scalar (nonlinear) equations : (Lec. 5 - 9)

Bisection method   Newton's method   Fixed point recursion

④ Solving square linear system $A\underline{x} = \underline{b}$: (Lec. 10 - 14)

↝ Understanding # of solutions
↝ LU decomposition, A\b, condition number, ill-conditioned system

⊙ <u>Interpolation problem</u> : (Lec. 14 - 16)
  ↝ Single polynomial fitting over the entire dataset,
      Vandermonde system

  ↝ Piecewise polynomial fitting : splines

⊙ <u>Function approximation problem</u> : (Lec. 17 - 20)
  ↝ Least squares problem $A\underline{x} \approx \underline{b}$ and its solution, QR
  ↝ MATLAB $A \backslash b$ for **tall** A matrix

  ↝ Data fitting/regression problems which are
      least squares problems
      → linear regression
      → polynomial regression
      → regression with arbitrary nonlinear functions
  ↝ Least norm problem and its solution : **wide** A matrix
  ↝ Ridge regression : reformulate as standard least squares

⊙ Numerical Differentiation : (Lec. 21)

↝ Computing f' → Forward difference : $O(h)$
→ Backward " : $O(h)$
→ 2 point Central " : $O(h^2)$

↝ Computing f'' → 3 point Central " : $O(h^2)$

⊙ Numerical Integration : (Lec. 21-22)

Midpoint method   Trapezoid method   3 point Simpson's method

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⊙ Solving ODE IVPs : (Lec. 22-23)

Forward Euler (explicit)   Backward Euler (implicit)   RK 2 (explicit)   RK 4 (explicit)   MATLAB ode 45 (explicit)

$O(h^2)$ $O(h^2)$ $O(h^3)$ $O(h^5)$ $O\left(\|\frac{\Delta t}{\infty}\|^5 \right)$

⊙ Special eigenvalue problems (Lec. 24 - 26)

→ Computing largest & smallest magnitude
    eig. value & corresponding eig. vector

→ Power iteration & inverse power iteration

→ Application case study : Google PageRank