

NUMERICAL METHODS

C / RAPPY EXAM 12 / 11/19 / 2022 [20.000]

LEAST SQUARES REGRESSION



$a_0 = \frac{\sum y_i}{n} - a_1 \bar{x}$
 $a_1 = \frac{\sum (x_i y_i) - \bar{x} \sum y_i}{\sum x_i^2 - n \bar{x}^2}$

POLYNOMIAL QUADRATIC REGRESSION:



$S_0 = \sum (y_i - a_0 - a_1 x_i - a_2 x_i^2)^2$
 $\frac{\partial S_0}{\partial a_0} = -2(\sum y_i - n a_0 - a_1 \sum x_i - a_2 \sum x_i^2) = 0$
 $\frac{\partial S_0}{\partial a_1} = -2(\sum x_i y_i - a_0 \sum x_i - a_1 \sum x_i^2 - a_2 \sum x_i^3) = 0$
 $\frac{\partial S_0}{\partial a_2} = -2(\sum x_i^2 y_i - a_0 \sum x_i^2 - a_1 \sum x_i^3 - a_2 \sum x_i^4) = 0$

STANDARD ERROR:

$S_{y_1} = \sqrt{\frac{\sum y_i^2}{n-2}}$ $S_{y_2} = \sqrt{\frac{\sum (y_i - \bar{y})^2}{n-2}}$

STANDARD DEVIATION:

$S_y = \sqrt{\frac{\sum y_i^2}{n-1}}$ $S_x = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$

$a_0 = \bar{y} - a_1 \bar{x}$
 $a_1 = \frac{\sum (x_i y_i) - \bar{x} \sum y_i}{\sum x_i^2 - n \bar{x}^2}$

INTERPOLATION



ODE'S

Euler's Method:
 $y_{n+1} = y_n + f(x_n, y_n) \Delta x$
Runge-Kutta Method:
 $y' = f(x, y)$
 $y_{n+1} = y_n + \frac{\Delta x}{2} [f(x_n, y_n) + f(x_{n+1}, y_{n+1})]$

Taylor Series:
 $y(x+\Delta x) = y(x) + \Delta x y'(x) + \frac{\Delta x^2}{2} y''(x) + \dots$

CLASSIC 4th ORDER RUNGE-KUTTA:

$y_{n+1} = y_n + \frac{\Delta x}{4} (k_1 + 2k_2 + 2k_3 + k_4)$
 $k_1 = f(x_n, y_n)$
 $k_2 = f(x_n + \frac{1}{2}\Delta x, y_n + \frac{1}{2}\Delta x k_1)$
 $k_3 = f(x_n + \frac{1}{2}\Delta x, y_n + \Delta x k_2)$
 $k_4 = f(x_n + \Delta x, y_n + \Delta x k_3)$

EIGEN VALUES

$A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$
 $\det(A - \lambda I) = \det \begin{bmatrix} a-\lambda & b \\ c & d-\lambda \end{bmatrix} = (a-\lambda)(d-\lambda) - bc = 0$
 $\lambda^2 - (a+d)\lambda + (ad-bc) = 0$
 $\lambda = \frac{(a+d) \pm \sqrt{(a+d)^2 - 4(ad-bc)}}{2}$

PDE'S

FINITE DIFFERENCE METHOD:



RIGHT BOUNDARY B.C.:
 $\frac{\partial u}{\partial x} = 0$
 $u_{i,j} = u_{i+1,j}$
TOP BOUNDARY B.C.:
 $\frac{\partial u}{\partial y} = 0$
 $u_{i,j} = u_{i,j+1}$
LEFT BOUNDARY B.C.:
 $\frac{\partial u}{\partial x} = 0$
 $u_{i,j} = u_{i-1,j}$
BOTTOM BOUNDARY B.C.:
 $\frac{\partial u}{\partial y} = 0$
 $u_{i,j} = u_{i,j-1}$

INTERNAL NODES:



RIGHT BOUNDARY B.C.:
 $\frac{\partial u}{\partial x} = 0$
 $u_{i,j} = \frac{u_{i-1,j} + u_{i+1,j}}{2}$
TOP BOUNDARY B.C.:
 $\frac{\partial u}{\partial y} = 0$
 $u_{i,j} = \frac{u_{i,j-1} + u_{i,j+1}}{2}$
LEFT BOUNDARY B.C.:
 $\frac{\partial u}{\partial x} = 0$
 $u_{i,j} = \frac{u_{i-1,j} + u_{i+1,j}}{2}$
BOTTOM BOUNDARY B.C.:
 $\frac{\partial u}{\partial y} = 0$
 $u_{i,j} = \frac{u_{i,j-1} + u_{i,j+1}}{2}$

[A] MATRIX:
 $u_{i,j} = \frac{u_{i-1,j} + u_{i+1,j} + u_{i,j-1} + u_{i,j+1}}{4} + \frac{\Delta x^2}{2} \frac{\partial^2 u}{\partial x^2} + \frac{\Delta y^2}{2} \frac{\partial^2 u}{\partial y^2} + \Delta x \Delta y \frac{\partial^2 u}{\partial x \partial y}$

TRUNCATION ERROR:

$\tau = \frac{f(x_{n+1}) - f(x_n)}{\Delta x} - f'(x_n)$
 $\tau = \frac{f(x_n + \Delta x) - f(x_n)}{\Delta x} - f'(x_n)$
 $\tau = \frac{f(x_n) + \Delta x f'(x_n) + \frac{\Delta x^2}{2} f''(x_n) + \dots - f(x_n)}{\Delta x} - f'(x_n)$
 $\tau = \frac{\Delta x f'(x_n) + \frac{\Delta x^2}{2} f''(x_n) + \dots}{\Delta x} - f'(x_n)$
 $\tau = f'(x_n) + \frac{\Delta x}{2} f''(x_n) + \dots - f'(x_n)$
 $\tau = \frac{\Delta x}{2} f''(x_n) + \dots$

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Yan Bai



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