

NUMERICAL METHODS

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

LEAST SQUARES REGRESSION



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

STANDARD ERROR:

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

STANDARD DEVIATION:

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

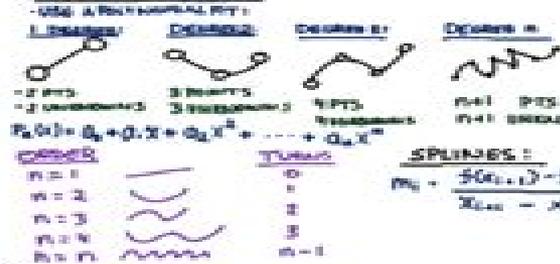
POLYNOMIAL QUADRATIC REGRESSION:



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

$$\begin{bmatrix} \sum 1 & \sum x_i & \sum x_i^2 \\ \sum x_i & \sum x_i^2 & \sum x_i^3 \\ \sum x_i^2 & \sum x_i^3 & \sum x_i^4 \end{bmatrix} \begin{bmatrix} a_0 \\ a_1 \\ a_2 \end{bmatrix} = \begin{bmatrix} \sum y_i \\ \sum x_i y_i \\ \sum x_i^2 y_i \end{bmatrix}$$

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:

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

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

INTERNAL B.C.:



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

5th ROW OF A MATRIX

$[0 \quad -1 \quad 0 \quad -1 \quad 4 \quad -1 \quad 0 \quad -1 \quad 0] \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \\ u_6 \\ u_7 \\ u_8 \\ u_9 \end{bmatrix} = 0$

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

TRUNCATION ERROR

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

Numerical Analysis Using R

S Marginson



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