NUMERICAL METHODS

r/KASEY — EXAM 2 — 11/14/2022

INTERPOLATION

USE A POLYNOMIAL FIT:

LINEAR	DEGREE 2	DEGREE 3	DEGREE n
2 PTS	3 POINTS	4 PTS	n+1 PTS
1 UNKNOWN	3 UNKNOWNS	4 UNKNOWNS	n+1 UNKNOWNS

$$f_n(x) = a_0 + a_1 x + a_2 x^2 + \cdots + a_n x^n$$

ORDER:
- n = 1
- n = 2
- n = 3
- n = 4

TURNS: 0, 1, 2, n-1

SPLINES:
$$m_i = \frac{f(x_{i+1}) - f(x_i)}{x_{i+1} - x_i}$$

LEAST SQUARES REGRESSION (LSR)

MINIMIZE THE SUM OF THE SQUARE OF THE RESIDUAL ERRORS

$$S_r = \sum e_i^2 = \sum (y_i - a_0 - a_1 x_i)^2$$

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

$$a_0 = \frac{\sum y_i}{n}, \quad a_1 = \frac{\sum x_i}{n} \Rightarrow a_0 = \bar{y} - a_1 \bar{x}$$

$$a_0 = \bar{y} - a_1 \bar{x}$$
$$y = a_0 + a_1 x$$

STANDARD ERROR:
$$S_{y} = \sqrt{\frac{S_r}{n-2}} \qquad S_{y/x} = \sqrt{\frac{\sum (y_i - y^{(n)})^2}{n-2}}$$

STND DEVIATION:
$$S_y = \sqrt{\frac{S_t}{n-1}} \qquad S_y = \sqrt{\frac{\sum (y_i - \bar{y})^2}{n-1}}$$

POLYNOMIAL (QUADRATIC REGRESSION):
$$S_r = \sum (y_i - a_0 - a_1 x_i - a_2 x_i^2)^2$$

TAKE DERIVATIVE OF S_r TO FIND THE MINIMUM

$$\frac{\partial S_r}{\partial a_0} = -2 \left(\sum y_i - \sum a_0 - a_1 \sum x_i - a_2 \sum x_i^2 \right) = 0$$

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

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

$$\sum_{i} a_i = a_0 n$$

$$[A][X] = [B]$$

$$S_{y/x} = \sqrt{\frac{S_r}{n-3}}$$

COEFFICIENT OF DETERMINATION
$$r^2 = \frac{S_t - S_r}{S_t}$$

ODE'S

EULER'S METHOD:
$$\frac{dy}{dx} = f(x,y) \qquad y_{i+1} = y_i + f(x_i, y_i)h$$

HEUN'S METHOD:
$$\frac{dy}{dx} = f(x,y)$$
$$x_{i+1} - y_i = f(x_i, y_i) \Delta x$$
$$\frac{dy}{dx} = y_i' = f(x_i, y_i)$$
$$\frac{dy}{dx} = y_i' = f(x_i, y_i)$$
$$y' = \frac{y_i' + y_{i+1}'}{2}, \quad \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^0)}{2}$$
$$y_{i+1} = y_i + \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^0)}{2} \Delta x$$

TAYLOR SERIES
$$y(x+\Delta x) = y(x) + \frac{dy}{dx}(x_0)\Delta x$$
$$y(x+\Delta x) = y(x) + f(x,y)\Delta x$$

CLASSIC 4TH ORDER RUNGE-KUTTA:
$$y_{i+1} = y_i + \frac{1}{6}(k_1 + 2k_2 + 2k_3 + k_4)\Delta x$$
$$k_1 = f(x_i, y_i)$$
$$k_2 = f(x_i + \tfrac{1}{2}\Delta x, \; y_i + \tfrac{1}{2}k_1 \Delta x)$$
$$k_3 = f(x_i + \tfrac{1}{2}\Delta x, \; y_i + \tfrac{1}{2}k_2 \Delta x)$$
$$k_4 = f(x_i + \Delta x, \; y_i + k_3 \Delta x)$$

DORMAND PRINCE RUNGE-KUTTA:
$$y_{i+1} = y_i + \Delta x \sum_{i=1}^{7} a_i k_i$$
$$y_{i+1} = y_i + \Delta x \sum_{i=1}^{7} a_i k_i$$

EIGEN VALUES

λ = EIGEN VALUE

$$\lambda = \frac{(a+d) \pm \sqrt{(a+d)^2 - 4(ad - bc)}}{2}$$

EIGENVECTOR
$$X_1 = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$$

PDE'S

FINITE DIFFERENCE METHOD:

- FORWARD DIFFERENCE
- DIVIDED DIFFERENCE
- BACKWARD DIFFERENCE

CENTRAL DIFFERENCE
$$u_{xx}(x,y) = \frac{u(x - \Delta x, y) - 2u(x,y) + u(x + \Delta x, y)}{\Delta x^2}$$
$$u_{yy}(x,y) = \frac{u(x, y - \Delta y) - 2u(x,y) + u(x, y + \Delta y)}{\Delta y^2}$$

TEMPERATURE

DIRICHLET:
L = 5, T = ... 0°C

BC:
- TEMP KNOWN @ BOUNDARY

DECOUPLED HEAT EQN:
$$u_t = k(u_{xx} + u_{yy}) + q$$

NEUMANN:
BC:
- TEMP DERIVATIVE KNOWN ON BOUNDARY

CENTRAL DIFFERENCE:
$$\frac{\partial u}{\partial x} = \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x}$$
$$\frac{\partial u}{\partial y} = q_0 = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta y}$$

RIGHT NEUMANN B.C.
$$\frac{\partial u}{\partial x} = q_0 = \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x}$$
$$u_{i+1,j} = u_{i-1,j} + 2\Delta x\, q_0$$

BOTTOM NEUMANN B.C.
$$\frac{\partial u}{\partial y} = q_0 = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta y}$$
$$u_{i,j-1} = u_{i,j+1} - 2\Delta y\, q_0$$

TOP NEUMANN BC
$$\frac{\partial u}{\partial y} = q_0 = \frac{u_{i,j+1} - u_{i,j-1}}{2\Delta y}$$
$$u_{i,j+1} = u_{i,j-1} + 2\Delta y\, q_0$$

LEFT NEUMANN B.C.
$$u_{i-1,j} = u_{i+1,j} - 2\Delta x\, q_0$$

[A] MATRIX:

LEFT:
$$u_{i-1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = -2\Delta x\, q_0$$

THIS CHANGED
$$-2u_{i+1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = -2\Delta x\, q_0$$

RIGHT:
$$-2u_{i-1,j} + 4u_{i,j} - u_{i,j-1} - u_{i,j+1} = -2\Delta x\, q_0$$

BOTTOM:
$$-2u_{i-1,j} - u_{i+1,j} + 4u_{i,j} - 2u_{i,j+1} = -2\Delta x\, q_0$$

TOP:
$$-u_{i-1,j} - u_{i+1,j} + 4u_{i,j} - 2u_{i,j-1} = -2\Delta x\, q_0$$

MISC EQN'S:
CENTERED FINITE DIVIDED DIFFERENCE FORMULA:

FIRST:
$$f'(x_i) = \frac{f(x_{i+1}) - f(x_{i-1})}{2h}$$
$$f'(x_i) = \frac{-f(x_{i+2}) + 8f(x_{i+1}) - 8f(x_{i-1}) + f(x_{i-2})}{12h}$$

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G Orfield

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Domain Decomposition Methods in Science and Engineering XIX Yunqing Huang,Ralf Kornhuber,Olof Widlund,Jinchao Xu,2010-10-27 These are the proceedings of the 19th international conference on domain decomposition methods in science and engineering Domain decomposition methods are iterative methods for solving the often very large linear or nonlinear systems of algebraic equations that arise in various problems in mathematics computational science engineering and industry They are designed for massively parallel computers and take the memory hierarchy of such systems into account This is essential for approaching peak floating point performance There is an increasingly well developed theory which is having a direct impact on the development and improvement of these algorithms   Advanced Multimedia and Ubiquitous Engineering James J. (Jong Hyuk) Park,Han-Chieh Chao,Hamid Arabnia,Neil Y. Yen,2015-05-26 This volume brings together contributions representing the state of the art in new multimedia and future technology information research currently a major topic in computer science and electronic engineering Researchers aim to interoperate multimedia frameworks transforming the way people work and interact with multimedia data This book covers future information technology topics including digital and multimedia convergence ubiquitous and pervasive computing intelligent computing and applications embedded systems mobile and wireless communications bio inspired computing grid and cloud computing semantic web human centric computing and social networks adaptive and context aware computing security and trust computing and related areas Representing the combined proceedings of the 9th International Conference on Multimedia and Ubiquitous Engineering MUE 15 and the 10th International Conference on Future Information Technology Future Tech 2015 this book aims to provide a complete coverage of the areas outlined and to bring together researchers from academic and industry and other practitioners to share their research ideas challenges and solutions   Parallel Processing and Applied Mathematics Roman Wyrzykowski,Jack Dongarra,Marcin Paprzycki,Jerzy Wasniewski,2003-08-01 This book constitutes the thoroughly refereed post proceedings of the 4th International Conference on Parallel Processing and Applied Mathematics PPAM 2002 held in Naleczow Poland in September 2001 The 101 papers presented were carefully reviewed and improved during two rounds of reviewing and revision The book offers topical sections on distributed and grid architectures scheduling and load balancing performance analysis and prediction parallel non numerical algorithms parallel programming tools and environments parallel numerical algorithms applications and evolutionary computing and neural networks   **Domain Decomposition Methods in Science and Engineering XX** Randolph Bank,Michael Holst,Olof Widlund,Jinchao Xu,2013-07-03 These are the proceedings of the 20th international conference on domain decomposition methods in science and engineering Domain decomposition methods are iterative methods for solving the often very large linearor nonlinear systems of algebraic equations that arise when various problems in continuum mechanics are discretized using finite elements They are designed for massively parallel computers and take the memory hierarchy of such systems in mind This is

essential for approaching peak floating point performance There is an increasingly well developed theory whichis having a direct impact on the development and improvements of these algorithms **Domain Decomposition Methods in Science and Engineering XXII** Thomas Dickopf,Martin J. Gander,Laurence Halpern,Rolf Krause,Luca F. Pavarino,2016-03-11 These are the proceedings of the 22nd International Conference on Domain Decomposition Methods which was held in Lugano Switzerland With 172 participants from over 24 countries this conference continued a long standing tradition of internationally oriented meetings on Domain Decomposition Methods The book features a well balanced mix of established and new topics such as the manifold theory of Schwarz Methods Isogeometric Analysis Discontinuous Galerkin Methods exploitation of modern HPC architectures and industrial applications As the conference program reflects the growing capabilities in terms of theory and available hardware allow increasingly complex non linear and multi physics simulations confirming the tremendous potential and flexibility of the domain decomposition concept Optimization with PDE Constraints Ronald Hoppe,2014-09-11 This book on PDE Constrained Optimization contains contributions on the mathematical analysis and numerical solution of constrained optimal control and optimization problems where a partial differential equation PDE or a system of PDEs appears as an essential part of the constraints The appropriate treatment of such problems requires a fundamental understanding of the subtle interplay between optimization in function spaces and numerical discretization techniques and relies on advanced methodologies from the theory of PDEs and numerical analysis as well as scientific computing The contributions reflect the work of the European Science Foundation Networking Programme Optimization with PDEs OPTPDE **Computational Intelligence in Emerging Technologies for Engineering Applications** Orestes Llanes Santiago,Carlos Cruz Corona,Antônio José Silva Neto,José Luis Verdegay,2020-02-14 This book explores applications of computational intelligence in key and emerging fields of engineering especially with regard to condition monitoring and fault diagnosis inverse problems decision support systems and optimization These applications can be beneficial in a broad range of contexts including water distribution networks manufacturing systems production and storage of electrical energy heat transfer acoustic levitation uncertainty and robustness of infinite dimensional objects fatigue failure prediction autonomous navigation nanotechnology and the analysis of technological development indexes All applications mathematical and computational tools and original results are presented using rigorous mathematical procedures Further the book gathers contributions by respected experts from 22 different research centers and eight countries Brazil Cuba France Hungary India Japan Romania and Spain The book is intended for use in graduate courses on applied computation applied mathematics and engineering where tools like computational intelligence and numerical methods are applied to the solution of real world problems in emerging areas of engineering *The Mechanical World* ,1912 **German books in print** ,2000 **Monthly Index of Russian Accessions** ,1958 **Agrindex** ,1990 *Bell Laboratories Talks and Papers* Bell Telephone Laboratories. Libraries and Information Systems Center,1974 Physics

<u>Briefs</u> ,1981　**Science Citation Index** ,1995 Vols for 1964 have guides and journal lists　**Who's Who in Science and Engineering 2008-2009** Who's Who Marquis,Marquis Who's Who,2007-12　<u>The IEEE Standard Dictionary of Electrical and Electronics Terms</u> Institute of Electrical and Electronics Engineers,Jane Radatz,Institute of Electrical and Electronics Engineers. Standards Coordinating Committee 10, Terms and Definitions,1997 Fr her u d T Institute of Electrical and Electronics Engineers The new IEEE standard dictionary of electrical and electronics terms　**Verzeichnis lieferbarer Bücher** ,1988　<u>Lecture Notes on Numerical Methods in Engineering and Sciences</u> ,2009　**Introduction To Numerical Computation, An (Second Edition)** Wen Shen,2019-08-28 This book serves as a set of lecture notes for a senior undergraduate level course on the introduction to numerical computation which was developed through 4 semesters of teaching the course over 10 years The book requires minimum background knowledge from the students including only a three semester of calculus and a bit on matrices The book covers many of the introductory topics for a first course in numerical computation which fits in the short time frame of a semester course Topics range from polynomial approximations and interpolation to numerical methods for ODEs and PDEs Emphasis was made more on algorithm development basic mathematical ideas behind the algorithms and the implementation in Matlab The book is supplemented by two sets of videos available through the author s YouTube channel Homework problem sets are provided for each chapter and complete answer sets are available for instructors upon request The second edition contains a set of selected advanced topics written in a self contained manner suitable for self learning or as additional material for an honored version of the course Videos are also available for these added topics　**Lecture Notes** Michael Hanke,Kungliga Tekniska högskolan. Institutionen för numerisk analys och datalogi,2006

The Top Books of the Year Numerical Methods Lecture Notes 01 Vsb The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the fascinating narratives that have enthralled audiences this year. Numerical Methods Lecture Notes 01 Vsb : Colleen Hoovers "It Ends with Us" This touching tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover skillfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can triumph. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This spellbinding historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Numerical Methods Lecture Notes 01 Vsb : Delia Owens "Where the Crawdads Sing" This captivating coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of engaging stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a brilliant and thrilling novel that will keep you wondering until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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