NUMERICAL METHODS

r/KAPPY EXAM 2 11/14/2022

LEAST SQUARES REGRESSION:

GOAL: MINIMIZE THE SUM OF THE SQUARE OF THE RESIDUAL ERRORS

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

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

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

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

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 PARAMETERS

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

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

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

$$\sum a_0 = a_0 n$$

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

$$S_{y/x} = \sqrt{\frac{S_r}{n-(m+1)}}$$

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

STANDARD ERROR:

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

STAND. DEVIATION:

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

INTERPOLATION

USE A POLYNOMIAL FIT:

LINEAR	QUADRATIC	DEGREE 3	DEGREE n
2 PTS	3 POINTS	4 PTS	n+1 PTS
1 UNKNOWN	3 UNKNOWNS	3 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:
$$m_i = \frac{f(x_{i+1}) - f(x_i)}{x_{i+1} - x_i}$$

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:
$$\frac{dy}{dx} = f(x,y)$$
$$x_{i+1} = y_i + f(x_i, y_i)\Delta x$$
$$\frac{dy}{dx} = y_i' = f(x_i, y_i)$$
$$\frac{dy}{dx} = y_i' = f(x_i, y_i)$$
$$y^* = \frac{y_i' + y_{i+1}'}{2} = \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^*)}{2}$$
$$y_{i+1} = y_i + \frac{f(x_i, y_i) + f(x_{i+1}, y_{i+1}^*)}{2}\Delta x$$

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:
$$y_{i+1} = y_i + \Delta x \sum a_i k_i$$
$$y_{i+1} = y_i + \Delta x \sum a_i k_i$$

EIGEN VALUES

λ = EIGEN VALUE

PDE'S

FINITE DIFFERENCE METHOD:

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

DIRICHLET:
$$T = 5^\circ C$$

BC:
TEMP KNOWN @ BOUNDARY
COUPLED HEAT EQN:
$$u_t = k(u_{xx} + u_{yy}) + q$$

NEUMANN:
BC:
TEMP DERIVATIVE KNOWN ON BOUNDARY
CENTRAL DIFFERENCE:
$$\frac{\partial u}{\partial x} = q_0 = \frac{u_{i+1,j} - u_{i-1,j}}{2\Delta x}$$

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

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

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

[A] MATRIX:

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

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

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

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

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Kasso A. Okoudjou

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   Group Theory and Numerical Analysis Pavel Winternitz,2005 The Workshop on Group Theory and Numerical Analysis brought together scientists working in several different but related areas The unifying theme was the application of group theory and geometrical methods to the solution of differential and difference equations The emphasis was on the combination of analytical and numerical methods and also the use of symbolic computation This meeting was organized under the auspices of the Centre de Recherches Mathematiques Universite de Montreal Canada This volume has the character of a monograph and should represent a useful reference book for scientists working in this highly topical field   High Performance Algorithms and Software in Nonlinear Optimization Renato de Leone,Almerico Murli,Panos M. Pardalos,Gerardo Toraldo,2013-12-01 This book contains a selection of papers presented at the conference on High Performance Software for Nonlinear Optimization HPSN097 which was held in Ischia Italy in June 1997 The rapid progress of computer technologies including new parallel architec tures has stimulated a large amount of research devoted to building software environments and defining algorithms able to fully exploit this new computa tional power In some sense numerical analysis has to conform itself to the new tools The impact of parallel computing in nonlinear optimization which had a slow start at the beginning seems now to increase at a fast rate and it is reasonable to expect an even greater acceleration in the future As with the first HPSNO conference the goal of the HPSN097 conference was to supply a broad overview of the more recent developments and trends in nonlinear optimization emphasizing the algorithmic and high performance software aspects Bringing together new computational methodologies with theoretical ad vances and new computer technologies is an exciting challenge that involves all scientists willing to develop high performance numerical software This book contains several important contributions from different and com plementary standpoints Obviously the articles in the book do not cover all the areas of the conference topic or all the most recent developments because of the large number of new theoretical and computational ideas of the last few years   **The 2011 Guide to Free Or Nearly-Free E-Books** ,2011 One of the problems which face all librarians adding e books to their collections is that of bibliographic control there is no legal deposit for e books and consequently there is no single place from which new titles can be found If this is true of commercially published e books it is most certainly also true of free e books and there are many thousands of free e books available over the Internet many of which are of a quality such that librarians might wish to have them in their collections The 2011 Guide to Free or Nearly Free e Books is offered as a tool for librarians and others involved in book selection e g teachers in schools in all sectors school further and higher education public and special libraries to facilitate easy access to free e books and e book collections which can enhance their digital library   Rigorous Numerics in Dynamics Jan Bouwe van den Berg,Jean-Philippe Lessard,2018-07-12 This volume is based on lectures delivered at the 2016 AMS Short Course Rigorous Numerics in Dynamics held January 4 5 2016 in Seattle Washington Nonlinear dynamics shapes the world around us from the harmonious

movements of celestial bodies via the swirling motions in fluid flows to the complicated biochemistry in the living cell Mathematically these phenomena are modeled by nonlinear dynamical systems in the form of ODEs PDEs and delay equations The presence of nonlinearities complicates the analysis and the difficulties are even greater for PDEs and delay equations which are naturally defined on infinite dimensional function spaces With the availability of powerful computers and sophisticated software numerical simulations have quickly become the primary tool to study the models However while the pace of progress increases one may ask just how reliable are our computations Even for finite dimensional ODEs this question naturally arises if the system under study is chaotic as small differences in initial conditions such as those due to rounding errors in numerical computations yield wildly diverging outcomes These issues have motivated the development of the field of rigorous numerics in dynamics which draws inspiration from ideas in scientific computing numerical analysis and approximation theory The articles included in this volume present novel techniques for the rigorous study of the dynamics of maps via the Conley index theory periodic orbits of delay differential equations via continuation methods invariant manifolds and connecting orbits the dynamics of models with unknown nonlinearities and bifurcations diagrams **The Mathematics of Data** Michael W. Mahoney,John C. Duchi,Anna C. Gilbert,2018-11-15 Nothing provided **An Excursion Through Discrete Differential Geometry** American Mathematical Society. Short Course, Discrete Differential Geometry,2020-09-02 Discrete Differential Geometry DDG is an emerging discipline at the boundary between mathematics and computer science It aims to translate concepts from classical differential geometry into a language that is purely finite and discrete and can hence be used by algorithms to reason about geometric data In contrast to standard numerical approximation the central philosophy of DDG is to faithfully and exactly preserve key invariants of geometric objects at the discrete level This process of translation from smooth to discrete helps to both illuminate the fundamental meaning behind geometric ideas and provide useful algorithmic guarantees This volume is based on lectures delivered at the 2018 AMS Short Course Discrete Differential Geometry held January 8 9 2018 in San Diego California The papers in this volume illustrate the principles of DDG via several recent topics discrete nets discrete differential operators discrete mappings discrete conformal geometry and discrete optimal transport *Applied Stochastic Analysis* Miranda Holmes-Cerfon,2024-10-30 This textbook introduces the major ideas of stochastic analysis with a view to modeling or simulating systems involving randomness Suitable for students and researchers in applied mathematics and related disciplines this book prepares readers to solve concrete problems arising in physically motivated models The author s practical approach avoids measure theory while retaining rigor for cases where it helps build techniques or intuition Topics covered include Markov chains discrete and continuous Gaussian processes It calculus and stochastic differential equations and their associated PDEs We ask questions such as How does probability evolve How do statistics evolve How can we solve for time dependent quantities such as first passage times How can we set up a model that includes fundamental principles such as time reversibility detailed balance How can we simulate a stochastic

process numerically Applied Stochastic Analysis invites readers to develop tools and insights for tackling physical systems involving randomness Exercises accompany the text throughout with frequent opportunities to implement simulation algorithms A strong undergraduate background in linear algebra probability ODEs and PDEs is assumed along with the mathematical sophistication characteristic of a graduate student **Finite Frame Theory: A Complete Introduction to Overcompleteness** Kasso A. Okoudjou,2016-07-13 Frames are overcomplete sets of vectors that can be used to stably and faithfully decompose and reconstruct vectors in the underlying vector space Frame theory stands at the intersection of many areas in mathematics such as functional and harmonic analysis numerical analysis matrix theory numerical linear algebra algebraic and differential geometry probability statistics and convex geometry At the same time its applications in engineering medicine computer science and quantum computing are motivating new research problems in applied and pure mathematics This volume is based on lectures delivered at the 2015 AMS Short Course Finite Frame Theory A Complete Introduction to Overcompleteness held January 8 9 2015 in San Antonio TX Mostly written in a tutorial style the seven chapters contained in this volume survey recent advances in the theory and applications of finite frames In particular it presents state of the art results on foundational frame problems and on the analysis and design of various frames mostly motivated by specific applications Carefully assembled the volume quickly introduces the non expert to the basic tools and techniques of frame theory It then moves to develop many recent results in the area and presents some important applications As such the volume is designed for a diverse audience including researchers in applied and computational harmonic analysis as well as engineers and graduate students **Geometric and Computational Spectral Theory** Alexandre Girouard,Dmitry Jakobson,Michael Levitin,Nilima Nigam,Iosif Polterovich,Frédéric Rochon,2017-10-30 A co publication of the AMS and Centre de Recherches Math matiques The book is a collection of lecture notes and survey papers based on the mini courses given by leading experts at the 2015 S minaire de Math matiques Sup rieures on Geometric and Computational Spectral Theory held from June 15 26 2015 at the Centre de Recherches Math matiques Universit de Montr al Montr al Quebec Canada The volume covers a broad variety of topics in spectral theory highlighting its connections to differential geometry mathematical physics and numerical analysis bringing together the theoretical and computational approaches to spectral theory and emphasizing the interplay between the two **CRM Proceedings & Lecture Notes** ,1998 **High Performance Computing and Applications** Jiang Xie,Zhangxin Chen,Craig C. Douglas,Wu Zhang,Yan Chen,2016-07-19 This book constitutes the thoroughly refereed proceedings of the Third International Conference on High Performance Computing and Applications HPCA 2015 held in Shanghai China in July 2015 The 24 revised full papers presented were carefully reviewed and selected from 50 submissions The papers cover the following research areas numerical algorithms and solutions high performance and grid computing novel approached to high performance computing massive data storage and processing hardware acceleration applications **Mathematics Today** ,2002 The New

Walford Guide to Reference Resources Ray Lester,2005 The New Walford highlights the best resources to use when undertaking a search for accurate and relevant information saving you precious time and effort For those looking for a selective and evaluative reference resource that really delivers on its promise look no further In addition to print sources The New Walford naturally covers an extensive range of e reference sources such as digital databanks digital reference services electronic journal collections meta search engines networked information services open archives resource discovery services and websites of premier organizations in both the public and private sectors But rather than supplying a list of all available known resources as a web search engine might The New Walford subject specialists have carefully selected and evaluated available resources to provide a definitive list of the most appropriate and useful With an emphasis on quality and sustainability the subject specialists have been careful to assess the differing ways that information is framed and communicated in different subject areas As a result the resource evaluations in each subject area are prefaced by an introductory overview of the structure of the relevant literature This ensures that The New Walford is clear easy to use and intuitive Publisher *Course Notes* ,1995 **Forthcoming Books** Rose Arny,2003-04 **New Perspectives on Microsoft Office 2003, First Course, Premium Edition** Ann Shaffer,Patrick Carey,Kathy Finnegan,Joseph Adamski,Roy Ageloff,2006-02-10 The case based problem solving approach to learning Office 2003 skills This Premium Edition includes an integrated training solution to transform the way your students learn Office 2003 skills Important Notice Media content referenced within the product description or the product text may not be available in the ebook version The Science Teacher ,1996 Bulletin Institute of Mathematics and Its Applications,1968 **School Science and Mathematics** ,1916 *Journal of the American Society of Mechanical Engineers* American Society of Mechanical Engineers,1918

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