Stochastic Approximation

Cost function. $J(w)$

Optimal solution. w^{opt}

Update procedure. $w_{t+1} = w_t + \lambda_t d(w_{old})$

Convergence. $w \to w^{opt}$

Criteria. $E[d(w)] = \nabla J(w)$

· $t \to \infty$

· $\lambda_t \to 0$

· $\sum \lambda_t = \infty$

$$\lambda_t = \frac{1}{t} \quad \text{or} \quad \lambda_t = \frac{1}{\sqrt{t}}$$

Caveat. Local minima

Stochastic Approximation

Harold Kushner,G. George Yin

Stochastic Approximation:

Stochastic Approximation and Recursive Algorithms and Applications Harold Kushner,G. George Yin,2006-05-04 The basic stochastic approximation algorithms introduced by Robbins and MonroandbyKieferandWolfowitzintheearly1950shavebeenthesubject of an enormous literature both theoretical and applied This is due to the large number of applications and the interesting theoretical issues in the analysis of dynamically de ned stochastic processes The basic paradigm is a stochastic di erence equation such as Y where takes n 1 n n n n its values in some Euclidean space Y is a random variable and the step n size 0 is small and might go to zero as n In its simplest form n is a parameter of a system and the random vector Y is a function of n noise corrupted observations taken on the system when the parameter is set to One recursively adjusts the parameter so that some goal is met n asymptotically Thisbookisconcernedwiththequalitativeandasymptotic properties of such recursive algorithms in the diverse forms in which they arise in applications There are analogous continuous time algorithms but the conditions and proofs are generally very close to those for the discrete time case The original work was motivated by the problem of nding a root of a continuous function g where the function is not known but the perimenter is able to take noisy measurements at any desired value of Recursive methods for root nding are common in classical numerical analysis and it is reasonable to expect that appropriate stochastic analogs would also perform well   Stochastic Approximation and Optimization of Random Systems L. Ljung,G. Pflug,H. Walk,2012-12-06 The DMV seminar Stochastische Approximation und Optimierung zufalliger Systeme was held at Blaubeuren 28 5 4 6 1989 The goal was to give an approach to theory and application of stochas tic approximation in view of optimization problems especially in engineering systems These notes are based on the seminar lectures They consist of three parts I Foundations of stochastic approximation H Walk n Applicational aspects of stochastic approximation G PHug In Applications to adaptation ugorithms L Ljung The prerequisites for reading this book are basic knowledge in probability mathematical statistics optimization We would like to thank Prof M Barner and Prof G Fischer for the or ganization of the seminar We also thank the participants for their cooperation and our assistants and secretaries for typing the manuscript November 1991 L Ljung G PHug H Walk Table of contents I Foundations of stochastic approximation H Walk 1 Almost sure convergence of stochastic approximation procedures 2 2 Recursive methods for linear problems 17 3 Stochastic optimization under stochastic constraints 22 4 A learning model recursive density estimation 27 5 Invariance principles in stochastic approximation 30 6 On the theory of large deviations 43 References for Part I 45 11 Applicational aspects of stochastic approximation G PHug 7 Markovian stochastic optimization and stochastic approximation procedures 53 8 Asymptotic distributions 71 9 Stopping times 79 1O Applications of stochastic approximation methods 80 References for Part II 90 III Applications to adaptation algorithms L   **Stochastic Approximation and Its Applications** Hanfu Chen,2002-08-31 Estimating unknown parameters based on observation data conta ing information about the parameters is ubiquitous in

diverse areas of both theory and application For example in system identification the unknown system coefficients are estimated on the basis of input output data of the control system in adaptive control systems the adaptive control gain should be defined based on observation data in such a way that the gain asymptotically tends to the optimal one in blind ch nel identification the channel coefficients are estimated using the output data obtained at the receiver in signal processing the optimal weighting matrix is estimated on the basis of observations in pattern classifi tion the parameters specifying the partition hyperplane are searched by learning and more examples may be added to this list All these parameter estimation problems can be transformed to a root seeking problem for an unknown function To see this let note the observation at time i e the information available about the unknown parameters at time It can be assumed that the parameter under estimation denoted by is a root of some unknown function This is not a restriction because for example may serve as such a function

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and also to some problems of information transmission in the presence of inverse feedback <u>Stochastic Approximation and Recursive Estimation</u> Rafail Zalmanovich Hasʹminskii,B. Silver, <u>Adaptive Algorithms and Stochastic Approximations</u> Albert Benveniste,Michel Metivier,Pierre Priouret,2012-12-06 Adaptive systems are widely encountered in many applications ranging through adaptive filtering and more generally adaptive signal processing systems identification and adaptive control to pattern recognition and machine intelligence adaptation is now recognised as keystone of intelligence within computerised systems These diverse areas echo the classes of models which conveniently describe each corresponding system Thus although there can hardly be a general theory of adaptive systems encompassing both the modelling task and the design of the adaptation procedure nevertheless these diverse issues have a major common component namely the use of adaptive algorithms also known as stochastic approximations in the mathematical statistics literature that is to say the adaptation procedure once all modelling problems have been resolved The juxtaposition of these two expressions in the title reflects the ambition of the authors to produce a reference work both for engineers who use these adaptive algorithms and for probabilists or statisticians who would like to study stochastic approximations in terms of problems arising from real applications Hence the book is organised in two parts the first one user oriented and the second providing the mathematical foundations to support the practice described in the first part The book covers the topcis of convergence convergence rate permanent adaptation and tracking change detection and is illustrated by various realistic applications originating from these areas of applications *American-Type Options* Dmitrii S. Silvestrov,2015-03-03 The book gives a systematical presentation of stochastic approximation methods for discrete time Markov price processes Advanced methods combining backward recurrence algorithms for computing of option rewards and general results on convergence of stochastic space skeleton and tree approximations for option rewards are applied to a variety of models of multivariate modulated Markov price processes The principal novelty of presented results is based on consideration of multivariate modulated Markov price processes and general pay off functions which can depend not only on price but also an additional stochastic modulating index component and use of minimal conditions of smoothness for transition probabilities and pay off functions compactness conditions for log price processes and rate of growth conditions for pay off functions The volume presents results on structural studies of optimal stopping domains Monte Carlo based approximation reward algorithms and convergence of American type options for autoregressive and continuous time models as well as results of the corresponding experimental studies **American-type Options** Dmitriĭ Sergeevich Silʹvestrov,2013-11 The book gives a systematical presentation of stochastic approximation methods for models of American type options with general pay off functions for discrete time Markov price processes This book is the first volume of the comprehensive two volumes monograph *Stochastic Approximation and Its Applications* Han-Fu Chen,2013-04-18 Estimating unknown parameters based on observation data conta ing information about the parameters is ubiquitous in diverse areas of both theory and application For example in system identification the

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understanding of algorithm behavior or qualitative dependence upon parameters etc without getting involved in a great deal of deta l **A New Dynamic Stochastic Approximation Procedure** David Ruppert,1977 **Nonlinear Filters** Sueo Sugimoto,Masaya Murata,Katsumi Ohnishi,Genshiro Kitagawa,Hisashi Tanizaki,Katsuji Uosaki,Kazufumi Ito,Kiyotugu Takaba,Masaaki Murata,Masaki Yamakita,Sarah A. King,Shinji Ishihara,Tohru Katayama,Yukihiro Kubo,2020-12-10 This book covers a broad range of filter theories algorithms and numerical examples The representative linear and nonlinear filters such as the Kalman filter the steady state Kalman filter the H infinity filter the extended Kalman filter the Gaussian sum filter the statistically linearized Kalman filter the unscented Kalman filter the Gaussian filter the cubature Kalman filter are first visited Then the non Gaussian filters such as the ensemble Kalman filter and the particle filters based on the sequential Bayesian filter and the sequential importance resampling are described together with their recent advances Moreover the information matrix in the nonlinear filtering the nonlinear smoother based on the Markov Chain Monte Carlo the continuous discrete filters factorized filters and nonlinear filters based on stochastic approximation method are detailed 1 Review of the Kalman Filter and Related Filters 2 Information Matrix in Nonlinear Filtering 3 Extended Kalman Filter and Gaussian Sum Filter 4 Statistically Linearized Kalman Filter 5 The Unscented Kalman Filter 6 General Gaussian Filters and Applications 7 The Ensemble Kalman Filter 8 Particle Filter 9 Nonlinear Smoother with Markov Chain Monte Carlo 10 Continuous Discrete Filters 11 Factorized Filters 12 Nonlinear Filters Based on Stochastic Approximation Method

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