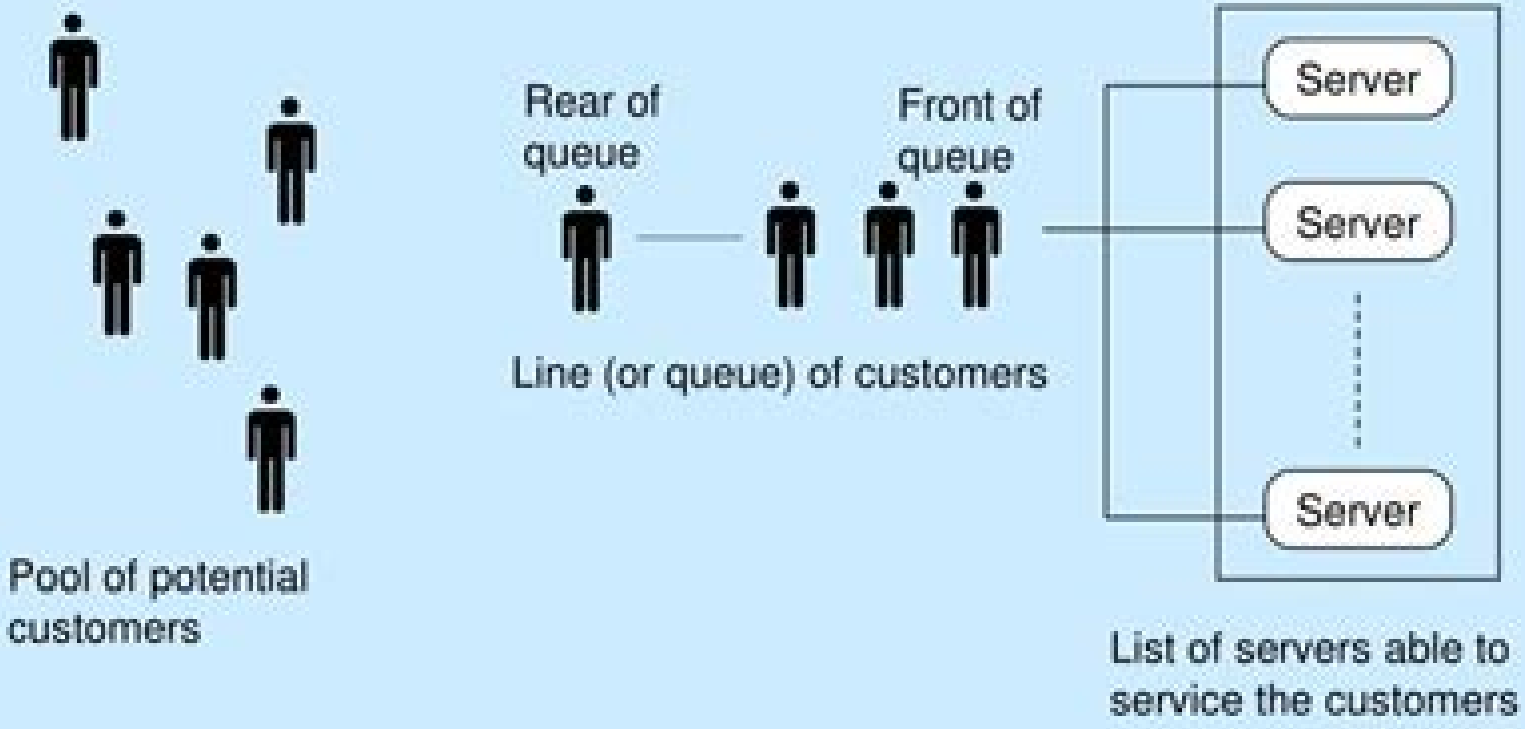
Queuing Theory

- **Queuing theory is the study of waiting in lines or queues.**



On Some Control Problems For Queues

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On Some Control Problems For Queues:

Fundamentals of Queueing Theory Donald Gross,John F. Shortle,James M. Thompson,Carl M. Harris,2011-09-23 Praise for the Third Edition This is one of the best books available Its excellent organizational structure allows quick reference to specific models and its clear presentation solidifies the understanding of the concepts being presented IIE Transactions on Operations Engineering Thoroughly revised and expanded to reflect the latest developments in the field Fundamentals of Queueing Theory Fourth Edition continues to present the basic statistical principles that are necessary to analyze the probabilistic nature of queues Rather than presenting a narrow focus on the subject this update illustrates the wide reaching fundamental concepts in queueing theory and its applications to diverse areas such as computer science engineering business and operations research This update takes a numerical approach to understanding and making probable estimations relating to queues with a comprehensive outline of simple and more advanced queueing models Newly featured topics of the Fourth Edition include Retrial queues Approximations for queueing networks Numerical inversion of transforms Determining the appropriate number of servers to balance quality and cost of service Each chapter provides a self contained presentation of key concepts and formulae allowing readers to work with each section independently while a summary table at the end of the book outlines the types of queues that have been discussed and their results In addition two new appendices have been added discussing transforms and generating functions as well as the fundamentals of differential and difference equations New examples are now included along with problems that incorporate QtsPlus software which is freely available via the book s related Web site With its accessible style and wealth of real world examples Fundamentals of Queueing Theory Fourth Edition is an ideal book for courses on queueing theory at the upper undergraduate and graduate levels It is also a valuable resource for researchers and practitioners who analyze congestion in the fields of telecommunications transportation aviation and management science Fundamentals of Queueing Theory John F. Shortle,James M. Thompson,Donald Gross,Carl M. Harris,2018-03-29 The definitive guide to queueing theory and its practical applications features numerous real world examples of scientific engineering and business applications Thoroughly updated and expanded to reflect the latest developments in the field Fundamentals of Queueing Theory Fifth Edition presents the statistical principles and processes involved in the analysis of the probabilistic nature of queues Rather than focus narrowly on a particular application area the authors illustrate the theory in practice across a range of fields from computer science and various engineering disciplines to business and operations research Critically the text also provides a numerical approach to understanding and making estimations with queueing theory and provides comprehensive coverage of both simple and advanced queueing models As with all preceding editions this latest update of the classic text features a unique blend of the theoretical and timely real world applications The introductory section has been reorganized with expanded coverage of qualitative non mathematical approaches to queueing theory including a high level description of queues in everyday life New sections on

non stationary fluid queues fairness in queueing and Little s Law have been added as has expanded coverage of stochastic processes including the Poisson process and Markov chains Each chapter provides a self contained presentation of key concepts and formulas to allow readers to focus independently on topics relevant to their interests A summary table at the end of the book outlines the queues that have been discussed and the types of results that have been obtained for each queue Examples from a range of disciplines highlight practical issues often encountered when applying the theory to real world problems A companion website features QtsPlus an Excel based software platform that provides computer based solutions for most queueing models presented in the book Featuring chapter end exercises and problems all of which have been classroom tested and refined by the authors in advanced undergraduate and graduate level courses Fundamentals of Queueing Theory Fifth Edition is an ideal textbook for courses in applied mathematics queueing theory probability and statistics and stochastic processes This book is also a valuable reference for practitioners in applied mathematics operations research engineering and industrial engineering **Probabilistic modeling for sensor fusion with inertial measurements** Manon Kok,2016-12-15 In recent years inertial sensors have undergone major developments The quality of their measurements has improved while their cost has decreased leading to an increase in availability They can be found in stand alone sensor units so called inertial measurement units but are nowadays also present in for instance any modern smartphone in Wii controllers and in virtual reality headsets The term inertial sensor refers to the combination of accelerometers and gyroscopes These measure the external specific force and the angular velocity respectively Integration of their measurements provides information about the sensor s position and orientation However the position and orientation estimates obtained by simple integration suffer from drift and are therefore only accurate on a short time scale In order to improve these estimates we combine the inertial sensors with additional sensors and models To combine these different sources of information also called sensor fusion we make use of probabilistic models to take the uncertainty of the different sources of information into account The first contribution of this thesis is a tutorial paper that describes the signal processing foundations underlying position and orientation estimation using inertial sensors In a second contribution we use data from multiple inertial sensors placed on the human body to estimate the body s pose A biomechanical model encodes the knowledge about how the different body segments are connected to each other We also show how the structure inherent to this problem can be exploited This opens up for processing long data sets and for solving the problem in a distributed manner Inertial sensors can also be combined with time of arrival measurements from an ultrawideband UWB system We focus both on calibration of the UWB setup and on sensor fusion of the inertial and UWB measurements The UWB measurements are modeled by a tailored heavy tailed asymmetric distribution This distribution naturally handles the possibility of measurement delays due to multipath and non line of sight conditions while not allowing for the possibility of measurements arriving early i e traveling faster than the speed of light Finally inertial sensors can be combined with magnetometers We derive an algorithm that can calibrate a

magnetometer for the presence of metallic objects attached to the sensor Furthermore the presence of metallic objects in the environment can be exploited by using them as a source of position information We present a method to build maps of the indoor magnetic field and experimentally show that if a map of the magnetic field is available accurate position estimates can be obtained by combining inertial and magnetometer measurements Closed-loop Diagnosis Using Submodels Du Ho,2025-04-30 Drones like many other mechanical systems operate under closed loop control to ensure safety and economic efficiency Real time feedback is crucial for a drone to follow its predefined missions and to deal with hazardous conditions Achieving optimal performance in such systems often requires a mathematical model typically obtained using system identification techniques Furthermore monitoring changes in the system is essential before an unexpected change leads to a fault and eventually a failure causing costly disruptions of the system This thesis investigates ways of obtaining robust fault detection and accurate parameter estimation in a closed loop system In detail we focus on subsystems of larger systems where the parameters or changes are observable This approach referred to as submodeling is adopted since examining the entire system dynamics can be challenging due to the complexities and interconnections between components Moreover it involves selecting and measuring only a subset of signals which reduces the number of sensors required However the resulting submodels use certain measurements as the outputs and others as the inputs yielding closed loop errors in variables EIV problems The first contribution addresses fault detection in closed loop EIV systems We apply a projection based nonadditive fault detection method where the residual is projected to a subspace that is orthogonal to additive faults and disturbances By doing so we demonstrate that additive and nonadditive faults can be decoupled making residuals sensitive only to the nonadditive ones This allows the nonadditive fault to be detected accurately despite the occurrence of additive faults closed loop effects and disturbances In the second contribution we establish a specific equivalence concept related to the residuals of models concerning input output repartitionings which is useful for studying estimators Moreover we show that the basic instrumental Variable IV estimator can yield equivalent estimates which are independent of the input output partitionings unlike other standard system identification methods The algebraic equivalence of the basic IV estimates holds regardless of the true system structure noise properties and data length The third contribution is to utilize the approach to derive submodels of a quadcopter More specifically we exploit the cancellation of shared dynamics between actual inputs and measured outputs allowing for the elimination of some input signals These submodels addressing various aspects of the quadcopter s dynamics are simpler than a complete model but still sufficient for the intended applications The fourth contribution is to validate all methods developed in this thesis using simulated and experimental data from a quadcopter To do so we apply a standard motion planning framework based on the simulation model of the drone to establish a detailed experimental procedure This procedure allows us to define scenarios similar to real world tasks of the drone in a testbed and to obtain excitation trajectories that produce informative data Both the simulated and experimental data based

validations show promising results *Gaussian Processes for Positioning Using Radio Signal Strength Measurements* Yuxin Zhao,2019-02-27 Estimation of unknown parameters is considered as one of the major research areas in statistical signal processing In the most recent decades approaches in estimation theory have become more and more attractive in practical applications Examples of such applications may include but are not limited to positioning using various measurable radio signals in indoor environments self navigation for autonomous cars image processing radar tracking and so on One issue that is usually encountered when solving an estimation problem is to identify a good system model which may have great impacts on the estimation performance In this thesis we are interested in studying estimation problems particularly in inferring the unknown positions from noisy radio signal measurements In addition the modeling of the system is studied by investigating the relationship between positions and radio signal strength measurements One of the main contributions of this thesis is to propose a novel indoor positioning framework based on proximity measurements which are obtained by quantizing the received signal strength measurements Sequential Monte Carlo methods to be more specific particle filter and smoother are utilized for estimating unknown positions from proximity measurements The Cram r Rao bounds for proximity based positioning are further derived as a benchmark for the positioning accuracy in this framework Secondly to improve the estimation performance Bayesian non parametric modeling namely Gaussian processes have been adopted to provide more accurate and flexible models for both dynamic motions and radio signal strength measurements Then the Cram r Rao bounds for Gaussian process based system models are derived and evaluated in an indoor positioning scenario In addition we estimate the positions of stationary devices by comparing the individual signal strength measurements with a pre constructed fingerprinting database The positioning accuracy is further compared to the case where a moving device is positioned using a time series of radio signal strength measurements Moreover Gaussian processes have been applied to sports analytics where trajectory modeling for athletes is studied The proposed framework can be further utilized to carry out for instance performance prediction and analysis health condition monitoring etc Finally a grey box modeling is proposed to analyze the forces particularly in cross country skiing races by combining a deterministic kinetic model with Gaussian process **Controllability of Complex Networks at Minimum Cost** Gustav Lindmark,2020-04-30 The control theoretic notion of controllability captures the ability to guide a system toward a desired state with a suitable choice of inputs Controllability of complex networks such as traffic networks gene regulatory networks power grids etc can for instance enable efficient operation or entirely new applicative possibilities However when control theory is applied to complex networks like these several challenges arise This thesis considers some of them in particular we investigate how a given network can be rendered controllable at a minimum cost by placement of control inputs or by growing the network with additional edges between its nodes As cost function we take either the number of control inputs that are needed or the energy that they must exert A control input is called unilateral if it can assume either positive or negative values but not both

Motivated by the many applications where unilateral controls are common we reformulate classical controllability results for this particular case into a more computationally efficient form that enables a large scale analysis Assuming that each control input targets only one node called a driver node we show that the unilateral controllability problem is to a high degree structural from topological properties of the network we derive theoretical lower bounds for the minimal number of unilateral control inputs bounds similar to those that have already been established for the minimal number of unconstrained control inputs e g can assume both positive and negative values With a constructive algorithm for unilateral control input placement we also show that the theoretical bounds can often be achieved A network may be controllable in theory but not in practice if for instance unreasonable amounts of control energy are required to steer it in some direction For the case with unconstrained control inputs we show that the control energy depends on the time constants of the modes of the network the longer they are the less energy is required for control We also present different strategies for the problem of placing driver nodes such that the control energy requirements are reduced assuming that theoretical controllability is not an issue For the most general class of networks we consider directed networks with arbitrary eigenvalues and thereby arbitrary time constants we suggest strategies based on a novel characterization of network non normality as imbalance in the distribution of energy over the network Our formulation allows to quantify network non normality at a node level as combination of two different centrality metrics The first measure quantifies the influence that each node has on the rest of the network while the second measure instead describes the ability to control a node indirectly from the other nodes Selecting the nodes that maximize the network non normality as driver nodes significantly reduces the energy needed for control Growing a network i e adding more edges to it is a promising alternative to reduce the energy needed to control it We approach this by deriving a sensitivity function that enables to quantify the impact of an edge modification with the H2 and H norms which in turn can be used to design edge additions that improve commonly used control energy metrics **Fighter Aircraft Maneuver Limiting Using MPC: Theory and Application** Daniel Simon,2017-09-12 Flight control design for modern fighter aircraft is a challenging task Aircraft are dynamical systems which naturally contain a variety of constraints and nonlinearities such as e g maximum permissible load factor angle of attack and control surface deflections Taking these limitations into account in the design of control systems is becoming increasingly important as the performance and complexity of the aircraft is constantly increasing The aeronautical industry has traditionally applied feedforward anti windup or similar techniques and different ad hoc engineering solutions to handle constraints on the aircraft However these approaches often rely on engineering experience and insight rather than a theoretical foundation and can often require a tremendous amount of time to tune In this thesis we investigate model predictive control as an alternative design tool to handle the constraints that arises in the flight control design We derive a simple reference tracking MPC algorithm for linear systems that build on the dual mode formulation with guaranteed stability and low complexity suitable for implementation in real time safety critical

systems To reduce the computational burden of nonlinear model predictive control we propose a method to handle the nonlinear constraints using a set of dynamically generated local inner polytopic approximations The main benefit of the proposed method is that while computationally cheap it still can guarantee recursive feasibility and convergence An alternative to deriving MPC algorithms with guaranteed stability properties is to analyze the closed loop stability post design Here we focus on deriving a tool based on Mixed Integer Linear Programming for analysis of the closed loop stability and robust stability of linear systems controlled with MPC controllers To test the performance of model predictive control for a real world example we design and implement a standard MPC controller in the development simulator for the JAS 39 Gripen aircraft at Saab Aeronautics This part of the thesis focuses on practical and tuning aspects of designing MPC controllers for fighter aircraft Finally we have compared the MPC design with an alternative approach to maneuver limiting using a command governor Sensor Management for Target Tracking Applications Per Boström-Rost,2021-04-12 Many practical applications such as search and rescue operations and environmental monitoring involve the use of mobile sensor platforms The workload of the sensor operators is becoming overwhelming as both the number of sensors and their complexity are increasing This thesis addresses the problem of automating sensor systems to support the operators This is often referred to as sensor management By planning trajectories for the sensor platforms and exploiting sensor characteristics the accuracy of the resulting state estimates can be improved The considered sensor management problems are formulated in the framework of stochastic optimal control where prior knowledge sensor models and environment models can be incorporated The core challenge lies in making decisions based on the predicted utility of future measurements In the special case of linear Gaussian measurement and motion models the estimation performance is independent of the actual measurements This reduces the problem of computing sensing trajectories to a deterministic optimal control problem for which standard numerical optimization techniques can be applied A theorem is formulated that makes it possible to reformulate a class of nonconvex optimization problems with matrix valued variables as convex optimization problems This theorem is then used to prove that globally optimal sensing trajectories can be computed using off the shelf optimization tools As in many other fields nonlinearities make sensor management problems more complicated Two approaches are derived to handle the randomness inherent in the nonlinear problem of tracking a maneuvering target using a mobile range bearing sensor with limited field of view The first approach uses deterministic sampling to predict several candidates of future target trajectories that are taken into account when planning the sensing trajectory This significantly increases the tracking performance compared to a conventional approach that neglects the uncertainty in the future target trajectory The second approach is a method to find the optimal range between the sensor and the target Given the size of the sensor s field of view and an assumption of the maximum acceleration of the target the optimal range is determined as the one that minimizes the tracking error while satisfying a user defined constraint on the probability of losing track of the target While optimization for tracking of a single

target may be difficult planning for jointly maintaining track of discovered targets and searching for yet undetected targets is even more challenging Conventional approaches are typically based on a traditional tracking method with separate handling of undetected targets Here it is shown that the Poisson multi Bernoulli mixture PMBM filter provides a theoretical foundation for a unified search and track method as it not only provides state estimates of discovered targets but also maintains an explicit representation of where undetected targets may be located Furthermore in an effort to decrease the computational complexity a version of the PMBM filter which uses a grid based intensity to represent undetected targets is derived

Accelerating Monte Carlo methods for Bayesian inference in dynamical models Johan Dahlin,2016-03-22 Making decisions and predictions from noisy observations are two important and challenging problems in many areas of society Some examples of applications are recommendation systems for online shopping and streaming services connecting genes with certain diseases and modelling climate change In this thesis we make use of Bayesian statistics to construct probabilistic models given prior information and historical data which can be used for decision support and predictions The main obstacle with this approach is that it often results in mathematical problems lacking analytical solutions To cope with this we make use of statistical simulation algorithms known as Monte Carlo methods to approximate the intractable solution These methods enjoy well understood statistical properties but are often computational prohibitive to employ The main contribution of this thesis is the exploration of different strategies for accelerating inference methods based on sequential Monte Carlo SMC and Markov chain Monte Carlo MCMC That is strategies for reducing the computational effort while keeping or improving the accuracy A major part of the thesis is devoted to proposing such strategies for the MCMC method known as the particle Metropolis Hastings PMH algorithm We investigate two strategies i introducing estimates of the gradient and Hessian of the target to better tailor the algorithm to the problem and ii introducing a positive correlation between the point wise estimates of the target Furthermore we propose an algorithm based on the combination of SMC and Gaussian process optimisation which can provide reasonable estimates of the posterior but with a significant decrease in computational effort compared with PMH Moreover we explore the use of sparseness priors for approximate inference in over parametrised mixed effects models and autoregressive processes This can potentially be a practical strategy for inference in the big data era Finally we propose a general method for increasing the accuracy of the parameter estimates in non linear state space models by applying a designed input signal Borde Riksbanken h ja eller s nka repor ntan vid sitt n sta m te f r att n inflationsm let Vilka gener r f rknippade med en viss sjukdom Hur kan Netflix och Spotify veta vilka filmer och vilken musik som jag vill lyssna p h rn st Dessa tre problem r exempel p fr gor d r statistiska modeller kan vara anv ndbara f r att ge hj lp och underlag f r beslut Statistiska modeller kombinerar teoretisk kunskap om exempelvis det svenska ekonomiska systemet med historisk data f r att ge prognoser av framtida skeenden Dessa prognoser kan sedan anv ndas f r att utv rdera exempelvis vad som skulle h nda med inflationen i Sverige om arbetsl sheten sjunker eller hur v rdet p mitt pensionssparande f r ndras n r

Stockholmsb rsen rasar Till mpningar som dessa och m nga andra g r statistiska modeller viktiga f r m nga delar av samh llet Ett s tt att ta fram statistiska modeller bygger p att kontinuerligt uppdatera en modell alltefter som mer information samlas in Detta angreppss tt kallas f r Bayesiansk statistik och r s rskilt anv ndbart n r man sedan tidigare har bra insikter i modellen eller tillg ng till endast lite historisk data f r att bygga modellen En nackdel med Bayesiansk statistik r att de ber kningar som kr vs f r att uppdatera modellen med den nya informationen ofta r mycket komplicerade I s dana situationer kan man ist llet simulera utfallet fr n miljontals varianter av modellen och sedan j mf ra dessa mot de historiska observationerna som finns till hands Man kan sedan medelv rdesbilda ver de varianter som gav b st resultat f r att p s s tt ta fram en slutlig modell Det kan d rf r ibland ta dagar eller veckor f r att ta fram en modell Problemet blir s rskilt stort n r man anv nder mer avancerade modeller som skulle kunna ge b ttre prognoser men som tar f r l ng tid f r att bygga I denna avhandling anv nder vi ett antal olika strategier f r att underl tta eller f rb ttra dessa simuleringar Vi f resl r exempelvis att ta h nsyn till fler insikter om systemet och d rmed minska antalet varianter av modellen som beh ver unders kas Vi kan s ledes redan utesluta vissa modeller eftersom vi har en bra uppfattning om ungef r hur en bra modell ska se ut Vi kan ocks f r ndra simuleringen s att den enklare r r sig mellan olika typer av modeller P detta s tt utforskas rymden av alla m jliga modeller p ett mer effektivt s tt Vi f resl r ett antal olika kombinationer och f r ndringar av befintliga metoder f r att snabba upp anpassningen av modellen till observationerna Vi visar att ber kningstiden i vissa fall kan minska ifr n n gra dagar till n gon timme F rhoppningsvis kommer detta i framtiden leda till att man i praktiken kan anv nda mer avancerade modeller som i sin tur resulterar i b ttre prognoser och beslut *Inverse system identification with applications in predistortion* Ylva Jung,2018-12-19 Models are commonly used to simulate events and processes and can be constructed from measured data using system identification The common way is to model the system from input to output but in this thesis we want to obtain the inverse of the system Power amplifiers PAs used in communication devices can be nonlinear and this causes interference in adjacent transmitting channels A prefilter called predistorter can be used to invert the effects of the PA such that the combination of predistorter and PA reconstructs an amplified version of the input signal In this thesis the predistortion problem has been investigated for outphasing power amplifiers where the input signal is decomposed into two branches that are amplified separately by highly efficient nonlinear amplifiers and then recombined We have formulated a model structure describing the imperfections in an outphasing abbrPA and the matching ideal predistorter The predistorter can be estimated from measured data in different ways Here the initially nonconvex optimization problem has been developed into a convex problem The predistorters have been evaluated in measurements The goal with the inverse models in this thesis is to use them in cascade with the systems to reconstruct the original input It is shown that the problems of identifying a model of a preinverse and a postinverse are fundamentally different It turns out that the true inverse is not necessarily the best one when noise is present and that other models and structures can lead to better inversion results To construct a predistorter for a PA for example a model of the

inverse is used and different methods can be used for the estimation One common method is to estimate a postinverse and then using it as a preinverse making it straightforward to try out different model structures Another is to construct a model of the system and then use it to estimate a preinverse in a second step This method identifies the inverse in the setup it will be used but leads to a complicated optimization problem A third option is to model the forward system and then invert it This method can be understood using standard identification theory in contrast to the ones above but the model is tuned for the forward system not the inverse Models obtained using the various methods capture different properties of the system and a more detailed analysis of the methods is presented for linear time invariant systems and linear approximations of block oriented systems The theory is also illustrated in examples When a preinverse is used the input to the system will be changed and typically the input data will be different than the original input This is why the estimation of preinverses is more complicated than for postinverses and one set of experimental data is not enough Here we have shown that identifying a preinverse in series with the system in repeated experiments can improve the inversion performance Performance and Implementation Aspects of Nonlinear Filtering Gustaf Hendeby,2008-02-15 Nonlinear filtering is an important standard tool for information and sensor fusion applications e g localization navigation and tracking It is an essential component in surveillance systems and of increasing importance for standard consumer products such as cellular phones with localization car navigation systems and augmented reality This thesis addresses several issues related to nonlinear filtering including performance analysis of filtering and detection algorithm analysis and various implementation details The most commonly used measure of filtering performance is the root mean square error RMSE which is bounded from below by the Cram r Rao lower bound CRLB This thesis presents a methodology to determine the effect different noise distributions have on the CRLB This leads up to an analysis of the intrinsic accuracy IA the informativeness of a noise distribution For linear systems the resulting expressions are direct and can be used to determine whether a problem is feasible or not and to indicate the efficacy of nonlinear methods such as the particle filter PF A similar analysis is used for change detection performance analysis which once again shows the importance of IA A problem with the RMSE evaluation is that it captures only one aspect of the resulting estimate and the distribution of the estimates can differ substantially To solve this problem the Kullback divergence has been evaluated demonstrating the shortcomings of pure RMSE evaluation Two estimation algorithms have been analyzed in more detail the Rao Blackwellized particle filter RBPF by some authors referred to as the marginalized particle filter MPF and the unscented Kalman filter UKF The RBPF analysis leads to a new way of presenting the algorithm thereby making it easier to implement In addition the presentation can possibly give new intuition for the RBPF as being a stochastic Kalman filter bank In the analysis of the UKF the focus is on the unscented transform UT The results include several simulation studies and a comparison with the Gauss approximation of the first and second order in the limit case This thesis presents an implementation of a parallelized PF and outlines an object oriented framework for filtering The

PF has been implemented on a graphics processing unit GPU i e a graphics card The GPU is a inexpensive parallel computational resource available with most modern computers and is rarely used to its full potential Being able to implement the PF in parallel makes new applications where speed and good performance are important possible The object oriented filtering framework provides the flexibility and performance needed for large scale Monte Carlo simulations using modern software design methodology It can also be used to help to efficiently turn a prototype into a finished product **Tracking the Wanders of Nature** Clas Veibäck,2018-11-20 Target tracking is a mature topic with over half a century of mainly military and aviation research The field has lately expanded into a range of civilian applications due to the development of cheap sensors and improved computational power With the rise of new applications new challenges emerge and with better hardware there is an opportunity to employ more elaborated algorithms There are five main contributions to the field of target tracking in this thesis Contributions I IV concern the development of non conventional models for target tracking and the resulting estimation methods Contribution V concerns a reformulation for improved performance To show the functionality and applicability of the contributions all proposed methods are applied to and verified on experimental data related to tracking of animals or other objects in nature In Contribution I sparse Gaussian processes are proposed to model behaviours of targets that are caused by influences from the environment such as wind or obstacles The influences are learned online as a part of the state estimation using an extended Kalman filter The method is also adapted to handle time varying influences and to identify dynamic systems It is shown to improve accuracy over the nearly constant velocity and acceleration models in simulation The method is also evaluated in a sea ice tracking application using data from a radar on Svalbard In Contribution II a state space model is derived that incorporates observations with uncertain timestamps An example of such observations could be traces left by a target Estimation accuracy is shown to be better than the alternative of disregarding the observation The position of an orienteering sprinter is improved using the control points as additional observations In Contribution III targets that are confined to a certain space such as animals in captivity are modelled to avoid collision with the boundaries by turning The proposed model forces the predictions to remain inside the confined space compared to conventional models that may suffer from infeasible predictions In particular the model improves robustness against occlusions The model is successfully used to track dolphins in a dolphinarium as they swim in a basin with occluded sections In Contribution IV an extension to the jump Markov model is proposed that incorporates observations of the mode that are state independent Normally the mode is estimated by comparing actual and predicted observations of the state However sensor signals may provide additional information directly dependent on the mode Such information from a video recorded by biologists is used to estimate take off times and directions of birds captured in circular cages The method is shown to compare well with a more time consuming manual method In Contribution V a reformulation of the labelled multi Bernoulli filter is used to exploit a structure of the algorithm to attain a more efficient implementation Modern target

tracking algorithms are often very demanding so sound approximations and clever implementations are needed to obtain reasonable computational performance The filter is integrated in a full framework for tracking sea ice from pre processing to presentation of results M lf ljning eng target tracking r ett v lutforskat mne med en historia som str cker sig tillbaka till tminstone 30 talet D t vlade en handfull nationer om att snabbast kunna uppt cka fienden innan det var f r sent Traditionellt sett har m lf ljning fortsatt att vara starkt f rknippat med milit ra till mpningar och flygfart Det r f rst p senare r som billiga och kommersiellt tillg ngliga sensorer har ppnat upp f r en m ngd betydligt fredligare anv ndningsomr den M lf ljning skulle kunna beskrivas som lokalisering av fr mmande objekt genom att samla in data fr n sensorer Den h r avhandlingen behandlar framf rallt m lf ljning av olika sorters djur d r data samlas in med videokameror Det finns tv bakomliggande syften Det ena handlar om att underl tta forskning f r biologer och det andra handlar om att skapa tekniska l sningar f r att underl tta skyddet av s llsynta djur ven m lf ljning av drivis d r data samlas in med radar behandlas Trots den vitt skilda till mpningen r m nga metoder desamma Syftet r att hantera drivis i norra ishavet d r detektion och m lf ljning r viktiga komponenter f r att undvika kollisioner Biologer l gger ofta en ansenlig m ngd tid p att samla in annotera och sortera data Det r tid som kan spenderas p mer givande forskningsaktiviteter Med videokamera bildbehandling och moderna algoritmer f r m lf ljning r det m jligt att i viss m n automatisera datainsamlingen Med automatisering kan mer information samlas in n med traditionella metoder och l ngre experiment kan ofta genomf ras Ytterligare en f rdel r att man kan minska p verkan p djuren Parkvakterna i m nga nationalparker k mpar dagligen med intr ng fr n tjuvj gare De har ytterst begr nsade resurser och uts tter sina liv f r stor fara Best nden minskar fortfarande f r m nga djurarter som g r en m rk framtid till m tes F r att v nda trenden beh vs stora insatser p m nga fronter samtidigt M lf ljning kan bidra med att p ett kostnadseffektivt s tt tillhandah lla vervakning av nationalparker K nnedom om var djuren befinner sig underl ttar koordinering av parkvakternas insatser f r att skydda djuren M lf ljning kan ske med ett flertal olika sensorer s som radarer fast uppsatta och luftburna videokameror mikrofoner som lyssnar efter djurl ten och ven vittnesm l fr n parkvakterna All insamlad information bidrar till att skapa en helhetsbild av situationen i nationalparken om den anv nds r tt Ishantering r ett viktigt omr de f r oljeindustrin f r att garantera s kerhet och undvika allvarliga olyckor M let r att uppt cka och sp ra is som flyter i havet och om n dv ndigt vidta tg rder f r att undvika kollision M let r att i f rl ngningen s tta upp ett stort n tverk av olika sensorer och databaser f r att f en helt ckande bild av det aktuella l get Flera k llor diskuteras s som mark och fartygsradarer av olika slag satelliter dr nare med kameror och v derdatabaser Att skapa fullst ndiga och anv ndbara l sningar f r biologer parkvakter och oljeindustrin r v ldigt ambiti sa m l I avhandlingen presenteras bakomliggande teori f r m lf ljning varvat med f rfattarens egna forskningsbidrag och l sningar f r en handfull specifika problem och till mpningar Det f rsta projektet som presenteras r ett samarbete med Kolm rdens djurpark Biologer i djurparken studerar delfiners beteende i f ngenskap I dagsl get markerar studenter f r hand i video var delfinerna befinner sig i bass ngen Med m lf ljning samlas djurens positioner in automatiskt

utan m nsklig inblandning Det fr msta bidraget i forskningen r utvecklingen av en modell f r hur delfinerna r r sig i bass ngen Det andra projektet som presenteras r ett samarbete med biologer vid Lunds universitet som studerar beteendet hos flyttf glar I en metod fr n 60 talet m ts f glars r relser i en tratt Fr n repor i tratten som orsakats vid f glarnas lyftf rs k analyserar man riktningarna f r lyftf rs ken Med videokamera och m lf ljning samlas djurens positioner in och enskilda lyftf rs k detekteras automatiskt Det fr msta bidraget i forskningen r en metod f r att b ttre utnyttja information fr n videon till att detektera lyftf rs ken Det tredje projektet som presenteras r ett samarbete med Smarta Savanner En id som utforskas r m jligheten att anv nda parkvakternas vittnesm l om sp r fr n nosh rningar f r att f rb ttra m lf ljningen ena sidan r data fr n videokameror och radarer v ldigt noggranna i tid men relativt os kra i de uppm tta positionerna andra sidan kan positionen f r ett sp r m tas noggrant samtidigt som det ofta r sv rt att avg ra n r nosh rningen var p platsen Genom att utnyttja informationen fr n b da k llorna kan nosh rningars f rflyttningar i parken kartl ggas b ttre Den bakomliggande teorin f r observationer med os ker tid inom m lf ljning r relativt outforskad Det fr msta bidraget i forskningen r utvecklingen av en metod f r att utnyttja s dana observationer Enkla simulerade fall anv nds f r att analysera metoden Metoden utv rderas ven i en till mpning f r att f rb ttra den satellitbaserade positionsbest mningen av en orienterare genom att noggrant m ta positionen p kontrollerna Det fj rde projektet som presenteras r ett samarbete med Norges teknisk naturvitenskapelige universitet NTNU och Norut i Norge som samlat in radardata p Svalbard Det fr msta bidraget r utvecklandet av en metod som l r sig hur lokala str mmar och vindar p verkar drivisen f r att b ttre kunna f rutsp r relser Ett annat bidrag i forskningen r en f renkling av formuleringen och implementationen av en modern algoritm f r m lf ljning Projekten som alla har flera likheter och skillnader med varandra kan gemensamt sammanfattas med att de sp rar r relser eller vandringar i naturen

Machine learning using approximate inference Christian Andersson Naesseth,2018-11-27 Automatic decision making and pattern recognition under uncertainty are difficult tasks that are ubiquitous in our everyday life The systems we design and technology we develop requires us to coherently represent and work with uncertainty in data Probabilistic models and probabilistic inference gives us a powerful framework for solving this problem Using this framework while enticing results in difficult to compute integrals and probabilities when conditioning on the observed data This means we have a need for approximate inference methods that solves the problem approximately using a systematic approach In this thesis we develop new methods for efficient approximate inference in probabilistic models There are generally two approaches to approximate inference variational methods and Monte Carlo methods In Monte Carlo methods we use a large number of random samples to approximate the integral of interest With variational methods on the other hand we turn the integration problem into that of an optimization problem We develop algorithms of both types and bridge the gap between them First we present a self contained tutorial to the popular sequential Monte Carlo SMC class of methods Next we propose new algorithms and applications based on SMC for approximate inference in probabilistic graphical models We derive nested sequential Monte

Carlo a new algorithm particularly well suited for inference in a large class of high dimensional probabilistic models Then inspired by similar ideas we derive interacting particle Markov chain Monte Carlo to make use of parallelization to speed up approximate inference for universal probabilistic programming languages After that we show how we can make use of the rejection sampling process when generating gamma distributed random variables to speed up variational inference Finally we bridge the gap between SMC and variational methods by developing variational sequential Monte Carlo a new flexible family of variational approximations Fuzzy Control of Queuing Systems Runtong Zhang,Yannis A. Phillis,Vassilis S. Kouikoglou,2005-12-06 Every day we experience the annoyance of having to queue The phenomenon is becoming more prevalent in our increasingly congested and urbanised society Not only the visible queues in traffic jams airport check in desks and supermarkets but the more common invisible queues caused by voice calls and data packets in optical and wireless channels Queues cost us time money and resources so what is the solution to our greater demand for services than there are facilities Queuing control plays a crucial role in manufacturing and communication networks around the world This pioneering approach using fuzzy control to solve queuing control problems determines explicit solutions to various types of control in queuing systems The bulk of results have been developed over the past decade and are presented here together for the first time 21 detailed case studies demonstrate an efficient departure from classical techniques Unique work creating a new Research and Development topic Multidisciplinary approach that will benefit researchers and students throughout the fields of artificial intelligence operations research optimal control Internet techniques communications and traffic control industries Equipped with an extensive bibliography for easy reference and scope for further study Existing practical problems especially those that are unresponsive to conventional control techniques are solved with the introduction of this novel approach A systematic framework of the fuzzy control of queuing networks is developed through each individual case

Flight Test System Identification Roger Larsson,2019-05-15 With the demand for more advanced fighter aircraft relying on unstable flight mechanical characteristics to gain flight performance more focus has been put on model based system engineering to help with the design work The flight control system design is one important part that relies on this modeling Therefore it has become more important to develop flight mechanical models that are highly accurate in the whole flight envelope For today s modern fighter aircraft the basic flight mechanical characteristics change between linear and nonlinear as well as stable and unstable as an effect of the desired capability of advanced maneuvering at subsonic transonic and supersonic speeds This thesis combines the subject of system identification which is the art of building mathematical models of dynamical systems based on measurements with aeronautical engineering in order to find methods for identifying flight mechanical characteristics Here some challenging aeronautical identification problems estimating model parameters from flight testing are treated Two aspects are considered The first is online identification during flight testing with the intent to aid the engineers in the analysis process when looking at the flight mechanical characteristics This will also ensure

that enough information is available in the resulting test data for post flight analysis Here a frequency domain method is used An existing method has been developed further by including an Instrumental Variable approach to take care of noisy data including atmospheric turbulence and by a sensor fusion step to handle varying excitation during an experiment The method treats linear systems that can be both stable and unstable working under feedback control An experiment has been performed on a radio controlled demonstrator aircraft For this multisine input signals have been designed and the results show that it is possible to perform more time efficient flight testing compared with standard input signals The other aspect is post flight identification of nonlinear characteristics Here the properties of a parameterized observer approach using a prediction error method are investigated This approach is compared with four other methods for some test cases It is shown that this parameterized observer approach is the most robust one with respect to noise disturbances and initial offsets Another attractive property is that no user parameters have to be tuned by the engineers in order to get the best performance All methods in this thesis have been validated on simulated data where the system is known and have also been tested on real flight test data Both of the investigated approaches show promising results **Advances in Mass Data Analysis of Images and Signals in Medicine, Biotechnology, Chemistry and Food Industry** Petra Perner,Ovidio Salvetti,2008-07-04 The automatic analysis of signals and images together with the characterization and elaboration of their representation features is still a challenging activity in many relevant scientific and hi tech fields such as medicine biotechnology and chemistry Multidimensional and multisource signal processing can generate a number of information patterns which can be useful to increase the knowledge of several domains for solving complex problems Furthermore advanced signal and image manipulation allows relating specific application problems into pattern recognition problems often implying also the development of KDD and other computational intelligence procedures Nevertheless the amount of data produced by sensors and equipments used in biomedicine biotechnology and chemistry is usually quite huge and structured thus strongly pushing the need of investigating advanced models and efficient computational algorithms for automating mass analysis procedures Accordingly signal and image understanding approaches able to generate automatically expected outputs become more and more essential including novel conceptual approaches and system architectures The purpose of this third edition of the International Conference on Mass Data Analysis of Signals and Images in Medicine Biotechnology Chemistry and Food Industry MDA 2008 www mda signals de was to present the broad and growing scientific evidence linking mass data analysis with challenging problems in medicine biotechnology and chemistry Scientific and engineering experts convened at the workshop to present the current understanding of image and signal processing and interpretation methods useful for facing various medical and biological problems and exploring the applicability and effectiveness of advanced techniques as solutions **Applied Discrete-Time Queues** Attahiru Alfa,2015-12-26 This book introduces the theoretical fundamentals for modeling queues in discrete time and the basic

procedures for developing queuing models in discrete time There is a focus on applications in modern telecommunication systems It presents how most queueing models in discrete time can be set up as discrete time Markov chains Techniques such as matrix analytic methods MAM that can used to analyze the resulting Markov chains are included This book covers single node systems tandem system and queueing networks It shows how queues with time varying parameters can be analyzed and illustrates numerical issues associated with computations for the discrete time queueing systems Optimal control of queues is also covered Applied Discrete Time Queues targets researchers advanced level students and analysts in the field of telecommunication networks It is suitable as a reference book and can also be used as a secondary text book in computer engineering and computer science Examples and exercises are included **Recent Trends In Optimization Theory And Applications** Ravi P Agarwal,1995-11-07 World Scientific Series in Applicable Analysis WSSIAA aims at reporting new developments of high mathematical standard and current interest Each volume in the series shall be devoted to the mathematical analysis that has been applied or potentially applicable to the solutions of scientific engineering and social problems This volume contains 30 research articles on the theory of optimization and its applications by the leading scientists in the field It is hoped that the material in the present volume will open new vistas in research Contributors B D O Anderson M Bertaja O J Boxma O Burdakov A Cantoni D J Clements B D Craven J B Cruz Jr P Diamond S V Drakunov Y G Evtushenko N M Filatov I Galligani J C Geromel F Giannessi M J Grimble G O Guardabassi D W Gu C H Houpis D G Hull C Itiki X Jian M A Johnson R E Kalaba J C Kalkkuhl M R Katebi T J Kim P Kloeden T Kobylarz A J Laub C S Lee G Leitmann B G Liu J Liu Z Q Luo K A Lurie P Maponi J B Matson A Mess G Pacelli M Pachter I Postlethwaite T Rapcsak M C Recchioni Y Sakawa S V Savastyuk K Schittkowski Y Shi M A Sikora D D Siljak K L Teo C Tovey P Tseng F E Udwadia H Unbehauen A Vladimirov B Vo J F Whidborne R Xu P L Yu V G Zhadan F Zirilli Numerical Methods for Stochastic Control Problems in Continuous Time Harold Kushner,Paul G. Dupuis,2013-11-27 Changes in the second edition The second edition differs from the first in that there is a full development of problems where the variance of the diffusion term and the jump distribution can be controlled Also a great deal of new material concerning deterministic problems has been added including very efficient algorithms for a class of problems of wide current interest This book is concerned with numerical methods for stochastic control and optimal stochastic control problems The random process models of the controlled or uncontrolled stochastic systems are either diffusions or jump diffusions Stochastic control is a very active area of research and new problem formulations and sometimes surprising applications appear regu larly We have chosen forms of the models which cover the great bulk of the formulations of the continuous time stochastic control problems which have appeared to date The standard formats are covered but much emphasis is given to the newer and less well known formulations The controlled process might be either stopped or absorbed on leaving a constraint set or upon first hitting a target set or it might be reflected or projected from the boundary of a constraining set In some of the more recent applications of the reflecting boundary problem

for example the so called heavy traffic approximation problems the directions of reflection are actually discontin uous In general the control might be representable as a bounded function or it might be of the so called impulsive or singular control types **Handbook of Markov Decision Processes** Eugene A. Feinberg,Adam Shwartz,2012-12-06 Eugene A Feinberg Adam Shwartz This volume deals with the theory of Markov Decision Processes MDPs and their applications Each chapter was written by a leading expert in the re spective area The papers cover major research areas and methodologies and discuss open questions and future research directions The papers can be read independently with the basic notation and concepts ofSection 1 2 Most chap ters should be accessible by graduate or advanced undergraduate students in fields of operations research electrical engineering and computer science 1 1 AN OVERVIEW OF MARKOV DECISION PROCESSES The theory of Markov Decision Processes also known under several other names including sequential stochastic optimization discrete time stochastic control and stochastic dynamic programming studiessequential optimization ofdiscrete time stochastic systems The basic object is a discrete time stochas tic system whose transition mechanism can be controlled over time Each control policy defines the stochastic process and values of objective functions associated with this process The goal is to select a good control policy In real life decisions that humans and computers make on all levels usually have two types ofimpacts i they cost orsavetime money or other resources or they bring revenues as well as ii they have an impact on the future by influencing the dynamics In many situations decisions with the largest immediate profit may not be good in view offuture events MDPs model this paradigm and provide results on the structure and existence of good policies and on methods for their calculation

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