Data Driven Fluid Simulations Using Regression Forests

An Eulerian approach to fluid flow provides an efficient, stable paradigm for realistic fluid simulation. However, its traditional reliance on a fixed-resolution grid is not ideal for simulations that simultaneously exhibit both large and small-scale fluid phenomena. Octree-based fluid simulation approaches have provided the needed adaptivity, but the inherent weakness of a pointer-based tree structure has limited their effectiveness. We present a linear octree structure that provides a significant runtime speedup using these octree-based simulation algorithms. As memory prices continue to decline, we leverage additional memory when compared to traditional octree structures to provide this improvement. In addition to reducing the level of indirection in the data, because our linear octree is stored contiguously in memory as a simple C array rather than a recursive set of pointers, we provide a more cache-friendly data layout than a traditional octree. In our testing, our approach yielded run-times that were 1.5 to nearly 5 times faster than the same simulations running on a traditional octree implementation.

Artificial Intelligence and Data Driven Optimization of Internal Combustion Engines summarizes recent developments in Artificial Intelligence (AI)/Machine Learning (ML) and data driven optimization and calibration techniques for internal combustion engines. The book covers AI/ML and data driven methods to optimize fuel formulations and engine combustion systems, predict cycle to cycle variations, and optimize after-treatment systems and experimental engine calibration. It contains all the details of the latest optimization techniques along with their application to ICE, making it ideal for automotive engineers, mechanical engineers, OEMs and R&D centers involved in engine design. Provides AI/ML and data driven optimization techniques in combination with Computational Fluid Dynamics (CFD) to optimize engine combustion systems Features a comprehensive overview of how AI/ML techniques are used in conjunction with simulations and experiments Discusses data driven optimization techniques for fuel formulations and vehicle control calibration

Distributing graphical fluid simulations across many machines enables faster and more detailed simulations. However, distributing these simulations efficiently is challenging. First, it requires writing efficient distributed simulation code. Graphical fluid simulations use many diverse, novel and optimized data structures. Existing production libraries contain code developed over decades. It is important to leave low level control over simulation data structures to applications, in order to support these different data structures and existing libraries. Second, even with well written code, it is necessary to distribute work evenly in order to run the simulation efficiently. Fluid simulations exhibit spatial and temporal variation in fluid distribution and computational load. This makes distributing work evenly difficult. Optimal decision making requires knowing future computational load, but computing this state automatically for an arbitrary simulation requires running the simulation itself. As a result, many simulations use a manually specified partitioning, a heuristic, or a reactive approach based on the current load. This dissertation shows that using coarse grained geometric descriptions about data and computations, it is possible for a system to automatically distribute such simulations efficiently by addressing these two challenges. It presents a four layer data model that allows a high level framework to automatically distribute grid-based and hybrid simulations over application owned data structures, and proposes a new approach, speculative load balancing to automatically distribute work evenly. The four layer data model supports complex data structures by providing a simple, geometric abstraction to the simulation author and library. It uses geometric information to translate between geometric views and disjoint system views for efficiently analyzing and enforcing dependencies, and to assemble complex application objects containing data in the format that the simulation library expects from underlying system objects. Speculative load balancing runs the same sequence of computations over a lower resolution grid to estimate future load, and uses these estimates to distribute work evenly. The lower resolution simulation runs orders of magnitude faster and adds negligible execution time overhead. Experimental results show that speculative load balancing outperforms traditional ways of distributing work.

Real-time Rendering of Data-driven Fluid Simulations with Style TransferSimulation of Fluid Flows Based on the Data-driven Evolution of Vortex Particles

This book constitutes the refereed post-conference proceedings of 10 workshops held at the 35th International ISC High Performance 2020 Conference, in Frankfurt, Germany, in June 2020: First Workshop on Compiler-assisted Correctness Checking and Performance Optimization for HPC (C3PO); First International Workshop on the Application of Machine Learning Techniques to Computational Fluid Dynamics Simulations and Analysis (CFDML); HPC I/O in the Data Center Workshop (HPC-IODC); First Workshop \Machine Learning on HPC Systems" (MLHPCS); First International Workshop on Monitoring and Data Analytics (MODA); 15th Workshop on Virtualization in High-Performance Cloud Computing (VHPC). The 25 full papers included in this volume were carefully reviewed and selected. They cover all aspects of research, development, and application of large-scale, high performance experimental and commercial systems. Topics include high-performance computing (HPC), computer architecture and hardware, programming models, system software, performance analysis and modeling, compiler analysis and optimization techniques, software sustainability, scientific applications, deep learning.

Implementing physical simulations for real-time games is a complex task that requires a solid understanding of a wide range of concepts from the fields of mathematics, physics, and software engineering. This book is a gems-like collection of practical articles in the area of game physics. Each provides hands-on detail that can be used in practical

The ability to derive models for dynamical systems is a central focus in many realms of science and engineering. However, for many systems of interest, the governing equations are either unknown or can only be evaluated to high accuracy at significant computational expense. Difficulties with modeling can be further exacerbated by additional complexities, such as high-dimensional states or nonlinearities in the dynamics. In turn, these challenges can hinder performance on important downstream tasks, such as prediction and control. This thesis presents techniques for learning dynamics models from data. By taking a data-driven approach, models can be derived even for systems with governing equations that are unknown or expensive to evaluate. Furthermore, training procedures can be tailored to provide learned models with desirable properties, such as low dimensionality (for efficient evaluation and storage) or linearity (for control). The proposed techniques are primarily evaluated on their ability to learn from data generated by computational fluid dynamics (CFD) simulations. CFD data serves as an ideal test case for data-driven techniques because the simulated fluid flows are nonlinear and can exhibit a wide array of behaviors. Additionally, modeling and even storage of CFD data can prove challenging due to the large number of degrees of freedom in many simulations, which can cause time snapshots of the flow field to contain megabytes or even gigabytes of data. First, this thesis proposes a multi-stage compression procedure to alleviate the storage overhead associated with running large-scale CFD simulations. Individual time snapshots are compressed through a combination of neural network autoencoders and principal component analysis. Subsequently, a dynamics model is learned that can faithfully propagate the compressed representations in time. The proposed method is able to compress the stored data by a factor of over a million, while still allowing for accurate reconstruction of all flow solutions at all time instances. The high computational cost of CFD simulations can make it impractical to run large numbers of simulations at diverse flow conditions. The second part of this thesis introduces a method for performing generative modeling, which allows for the efficient simulation of fluid flows at a wide range of flow conditions given data from only a subset of those conditions. The proposed method, which relies upon techniques from variational inference, is shown to generate accurate simulations at a range of conditions for both two- and three-dimensional fluid flow problems. The equations that govern fluid flow are nonlinear, meaning that many control techniques, largely derived for linear systems, prove ineffective when applied to fluid flow control. This thesis proposes a method, grounded in Koopman theory, for discovering data-driven linear models that can approximate the forced dynamics of systems with nonlinear dynamics. The method is shown to produce stable dynamics models that can accurately predict the time evolution of airflow over a cylinder. Furthermore, by performing model predictive control with the learned models, a straightforward, interpretable control law is found that is capable of suppressing vortex shedding in the cylinder wake. In the final part of this thesis, the Deep Variational Koopman (DVK) model is introduced, which is a method for inferring distributions over Koopman observations that can be propagated linearly in time. By sampling from the inferred distributions, an ensemble of dynamics models is obtained, which in turn provides a distribution over possible outcomes as a modeled system advances in time. Experiments show that the DVK model is capable of accurate, long-term prediction for a variety of dynamical systems. Furthermore, it is demonstrated that accounting for the uncertainty present in the distribution over dynamics models enables more effective control.

The integration of machine learning techniques and cartoon animation research is fast becoming a hot topic. This book helps readers learn the latest machine learning techniques, including patch alignment framework; spectral clustering, graph cuts, and convex relaxation; ensemble manifold learning; multiple kernel learning; multiview subspace learning; and multiview distance metric learning. It then presents the applications of these modern machine learning techniques in cartoon animation research. With these techniques, users can efficiently utilize the cartoon materials to generate animations in areas such as virtual reality, video games, animation films, and sport simulations

This book focuses on the core areas of computing and their applications in the real world. Presenting papers from the Computing Conference 2020 covers a diverse range of research areas, describing various detailed techniques that have been developed and implemented. The Computing Conference 2020, which provided a venue for academic and industry practitioners to share new ideas and development experiences, attracted a total of 514 submissions from pioneering academic researchers, scientists, industrial engineers and students from around the globe. Following a double-blind, peer-review process, 160 papers (including 15 poster papers) were selected to be included in these proceedings. Featuring state-of-the-art intelligent methods and techniques for solving real-world problems, the book is a valuable resource and will inspire further research and technological improvements in this important area.

This beginning graduate textbook teaches data science and machine learning methods for modeling, prediction, and control of complex systems.

This book constitutes the refereed post-conference proceedings of the 6th International Workshop on Accelerator Programming Using Directives, WACCPD 2019, held in Denver, CO, USA, in November 2019. The 7 full papers presented have been carefully reviewed and selected from 13 submissions. The papers share knowledge and experiences to program emerging complex parallel computing systems. They are organized in the following three sections: porting scientific applications to heterogeneous architectures using directives; directive-based programming for math libraries; and performance portability for heterogeneous architectures.

This book shows how neural networks are applied to computational mechanics. Part I presents the fundamentals of neural networks and other machine learning methods in computational mechanics. Part II highlights the applications of neural networks to a variety of problems of computational mechanics. The final chapter gives perspectives to the applications of the deep learning to computational mechanics.

The material included in this book provides selected presentations given at the international symposium MEIS2014. The book aims to provide a unique venue where various issues in computer graphics (CG) application fields are discussed by mathematicians as well as CG researchers and practitioners. The target audience is not limited to researchers in academia but also those in industries with a strong interest in digital media creation, scientific visualization and visual engineering.

The two-volume set LNAI 12084 and 12085 constitutes the thoroughly refereed proceedings of the 24th Pacific-Asia Conference on Knowledge Discovery and Data Mining, PAKDD 2020, which was due to be held in Singapore, in May 2020. The conference was held virtually due to the COVID-19 pandemic. The 135 full papers presented were carefully reviewed and selected from 628 submissions. The papers present new ideas, original research results, and practical development experiences from all KDD related areas, including data mining, data warehousing, machine learning, artificial intelligence, databases, statistics, knowledge engineering, visualization, decision-making systems, and the emerging applications. They are organized in the following topical sections: recommender systems; classification; clustering; mining social networks; representation learning and embedding; mining behavioral data; deep learning; feature extraction and selection; human, domain, organizational and social factors in data mining; mining sequential data; mining imbalanced data; association; privacy and security; supervised learning; novel algorithms; mining multi-media/multi-dimensional data; application; mining graph and network data; anomaly detection and analytics; mining spatial, temporal, unstructured and semi-structured data; sentiment analysis; statistical/graphical model; multi-source/distributed/parallel/cloud computing.

This book gathers the latest advances, innovations, and applications in the field of computational engineering, as presented by leading international researchers and engineers at the 26th International Conference on Computational & Experimental Engineering and Sciences (ICCES), held in Phuket, Thailand on January 6-10, 2021. ICCES covers all aspects of applied sciences and engineering: theoretical, analytical, computational, and experimental studies and solutions of problems in the physical, chemical, biological, mechanical, electrical, and mathematical sciences. As such, the book discusses highly diverse topics, including composites; bioengineering & biomechanics; geotechnical engineering; offshore & arctic engineering; multi-scale & multi-physics fluid engineering; structural integrity & longevity; materials design & simulation; and computer modeling methods in engineering. The contributions, which were selected by means of a rigorous international peer-review process, highlight numerous exciting ideas that will spur novel research directions and foster multidisciplinary collaborations.

Data-Based Controller Design presents a comprehensive analysis of data-based control design. It brings together the different data-based design methods that have been presented in the literature since the late 1990’s. To the best knowledge of the author, these data-based design methods have never been collected in a single text, analyzed in depth or compared to each other, and this severely limits their widespread application. In this book these methods will be presented under a common theoretical framework, which fits also a large family of adaptive control methods: the MRAC (Model Reference Adaptive Control) methods. This common theoretical framework has been developed and presented very recently. The book is primarily intended for PhD students and researchers - senior or junior - in control systems. It should serve as teaching material for data-based and adaptive control courses at the graduate level, as well as for reference material for PhD theses. It should also be useful for advanced engineers willing to apply data-based design. As a matter of fact, the concepts in this book are being used, under the author's supervision, for developing new software products in a automation company. The book will present simulation examples along the text. Practical applications of the concepts and methodologies will be presented in a specific chapter.

This book presents methodologies for analysing large data sets produced by the direct numerical simulation (DNS) of turbulence and combustion. It describes the development of models that can be used to analyse large eddy simulations, and highlights both the most common techniques and newly emerging ones. The chapters, written by internationally respected experts, invite readers to consider DNS of turbulence and combustion from a formal, data-driven standpoint, rather than one led by experience and intuition. This perspective allows readers to recognise the shortcomings of existing models, with the ultimate goal of quantifying and reducing model-based uncertainty. In addition, recent advances in machine learning and statistical inferences offer new insights on the interpretation of DNS data. The book will especially benefit graduate-level students and researchers in mechanical and aerospace engineering, e.g. those with an interest in general fluid mechanics, applied mathematics, and the environmental and atmospheric sciences.

The five-volume set LNCS 11536, 11537, 11538, 11539 and 11540 constitutes the proceedings of the 19th International Conference on Computational Science, ICCS 2019, held in Faro, Portugal, in June 2019. The total of 65 full papers and 168 workshop papers presented in this book set were carefully reviewed and selected from 573 submissions (228 submissions to the main track and 345 submissions to the workshops). The papers were organized in topical sections named: Part I: ICCS Main Track Part II: ICCS Main Track; Track of Advances in High-Performance Computational Earth Sciences: Applications and Frameworks; Track of Agent-Based Simulations, Adaptive Algorithms and Solvers; Track of Applications of Matrix Methods in Artificial Intelligence and Machine Learning; Track of Architecture, Languages, Compilation and Hardware Support for Emerging and Heterogeneous Systems Part III: Track of Biomedical and Bioinformatics Challenges for Computer Science; Track of Classifier Learning from Difficult Data; Track of Computational Finance and Business Intelligence; Track of Computational Optimization, Modelling and Simulation; Track of Computational Science in IoT and Smart Systems Part IV: Track of Data-Driven Computational Sciences; Track of Machine Learning and Data Assimilation for Dynamical Systems; Track of Marine Computing in the Interconnected World for the Benefit of the Society; Track of Multiscale Modelling and Simulation; Track of Simulations of Flow and Transport: Modeling, Algorithms and Computation Part V: Track of Smart Systems: Computer Vision, Sensor Networks and Machine Learning; Track of Solving Problems with Uncertainties; Track of Teaching Computational Science; Poster Track ICCS 2019 Chapter "Comparing Domain-decomposition Methods for the Parallelization of Distributed Land Surface Models" is available open access under a Creative Commons Attribution 4.0 International License via link.springer.com.

This work explores data-driven methods, including sparse sampling, modal decomposition and machine learning techniques, for high-dimensional systems in fluid dynamics. Fluid flows are characterized by their nonlinearity, multi-scale structures and unsteady behaviors. Understanding the patterns and their evolving dynamics is crucial for control purposes. Robust control calls on fast signal processing and real-time decisions made in the online stage. Modern data science enables appropriate basis transformations that facilitate efficient sensing strategies for state-space estimation, prediction and control. This thesis builds models to save tremendous online experimental and computational power, by transferring the burden in solving optimization problems to the offline stage. It applies to a variety of real engineering applications, including, but not limited to PIV/optical data collection in wind/water tunnel and DNS/LES simulation data. The data-driven methods developed here apply broadly to high-dimensional complex systems from experiments and simulations, and offer a paradigm shift in our ability to measure, model, and manipulate fluid flows efficiently. They provide physical interpretability of the data that will hopefully lead to future developments in the use of artificial intelligence in real systems.

Data driven analytics is enjoying unprecedented popularity among oil and gas professionals. Many reservoir engineering problems associated with geological storage of CO2 require the development of numerical reservoir simulation models. This book is the first to examine the contribution of Artificial Intelligence and Machine Learning in data driven analytics of fluid flow in porous environments, including saline aquifers and depleted gas and oil reservoirs. Drawing from actual case studies, this book demonstrates how smart proxy models can be developed for complex numerical reservoir simulation models. Smart proxy incorporates pattern recognition capabilities of Artificial Intelligence and Machine Learning to build smart models that learn the intricacies of physical, mechanical and chemical interactions using precise numerical simulations. This ground breaking technology makes it possible and practical to use high fidelity, complex numerical reservoir simulation models in the design, analysis and optimization of carbon storage in geological formations projects.

This three-volume set LNCS 12888, 12898, and 12890 constitutes the refereed conference proceedings of the 11th International Conference on Image and Graphics, ICIG 2021, held in Haikou, China, in August 2021.* The 198 full papers presented were selected from 421 submissions and focus on advances of theory, techniques and algorithms as well as innovative technologies of image, video and graphics processing and fostering innovation, entrepreneurship, and networking. *The conference was postponed due to the COVID-19 pandemic.

Research into the methods and techniques used in simulating crowds has developed extensively within the last few years, particularly in the areas of video games and film. Despite recent impressive results when simulating and rendering thousands of individuals, many challenges still exist in this area. The comparison of simulation with reality, the realistic appearance of virtual humans and their behavior, group structure and their motion, and collision avoidance are just some examples of these challenges. For most of the applications of crowds, it is now a requirement to have real-time simulations – which is an additional challenge, particularly when crowds are very large. Crowd Simulation analyses these challenges in depth and suggests many possible solutions. Daniel Thalmann and Soraia Musse share their experiences and expertise in the application of: · Population modeling · Virtual human animation · Behavioral models for crowds · The connection between virtual and real crowds · Path planning and navigation · Visual attention models · Geometric and populated semantic environments · Crowd rendering The second edition presents techniques and methods developed since the authors first covered the simulation of crowds in 2007. Crowd Simulation includes in-depth discussions on the techniques of path planning, including a new hybrid approach between navigation graphs and potential-based methods. The importance of gaze attention – individuals appearing conscious of their environment and of others – is introduced, and a free-of-collision method for crowds is also discussed.

Fluid solvers that provide accurate and fast fluid simulations are of great importance in many scientific and engineering disciplines. Conventional numerical solvers based on the Eulerian description of the flow provide highly accurate solutions to the Navier-Stokes equations. However, there is typically a significant amount of computational effort is required to execute such Eulerian simulations. On the other hand, fluid solvers built on the Lagrangian description of the flow are more appealing in terms of its vicinity to the true physics, since it treats the actual fluid particles as the primary computational elements. A particular group of Lagrangian particle methods based on vorticity, instead of velocity, as the primary flow variable, delivers velocity field solutions, which are always divergence-free. These vortex methods have an inherent advantage that the particles need to be present only in the regions where vorticity exists, and therefore fewer fluid particles are required to execute simulations as compared to their counterparts with velocity-based formulations. Recently, deep learning solutions for fluid dynamics problems by the application of artificial neural networks has become more prominent. Neural networks encode the information about the governing laws of fluid dynamics in its parameters using the knowledge extracted from data samples during training. The aim of this work is to use deep learning to learn fluid dynamics with Lagrangian vortex particles as the primary flow representation. Solution strategies to train and evaluate the neural networks for predicting Lagrangian vortex particle dynamics for different flow scenarios are presented throughout this work. Conceptualization and implementation of an approach to model interaction between vortex particles based on the Taylor series expansion of the velocity form the core of this work. We demonstrate that our trained neural networks produce fluid simulations with reasonable accuracy for different flow scenarios while respecting appropriate constraints pertaining to fluid dynamics.

Smoothed Particle Hydrodynamics (SPH) is a mesh-free method that has been widely used in several fields such as astrophysics, solids mechanics, and fluid dynamics. This computational fluid dynamics model has been extensively studied and is mature enough to enable detailed quantitative comparisons with laboratory experiments. Therefore, understanding and revealing the underneath behaviors of SPH fluid simulation becomes more meaningful when SPH is used to help us understand similar phenomena in the real world. In the thesis, we use the Finite Time Lyapunov Exponent (FTLE) and a novel rotation metric as well as other analysis methods to analyze the SPH. First of all, we modify traditional FTLE by using Moving Least Squares to calculate the deformation matrix, and extend the usage from mesh-based to mesh-free data sets; we are the first to apply FTLE on free surface SPH fluid simulation. In addition, we are the first to apply rotation sum and gradient of rotation sum on particles based fluid simulation. We present a new way of using Moving Least Squares to calculate the gradient of rotation sum for mesh-free data sets. What's more, we are the first to apply asymmetric tensor field analysis on particle based fluid simulation. Furthermore, we utilize a number of visualization techniques on different analysis results. We present why choosing a proper visualization is crucial to reveal useful information, and we also demonstrate how to utilize transfer functions to decrease perturbations of data sets. Lastly, we compare different analysis results, such as FTLE versus gradient of rotation sum. Our methods are also useful to enhance the rendering of SPH simulation results, which reveals many small-scale detailed flow behaviors that would not be seen using existing rendering approaches. Our results are more realistic in terms of revealing the underneath behaviors of fluid simulation.

This book gathers selected high-quality research papers presented at the Sixth International Congress on Information and Communication Technology, held at Brunel University, London, on February 25-26, 2021. It discusses emerging topics pertaining to information and communication technology (ICT) for managerial applications, e-governance, e-agriculture, e-education and computing technologies, the Internet of things (IoT) and e-mining. Written by respected experts and researchers working on ICT, the book offers a valuable asset for young researchers involved in advanced studies. The book is presented in four volumes.

Presents numerical methods for reservoir simulation, with efficient implementation and examples using widely-used online open-source code, for researchers, professionals and advanced students. This title is also available as Open Access on Cambridge Core.

This edited volume is devoted to the now-ubiquitous use of computational models across most disciplines of engineering and science, led by a trio of world-renowned researchers in the field. Focused on recent advances of modeling and optimization techniques aimed at handling computationally-expensive engineering problems involving simulation models, this book will be an invaluable resource for specialists (engineers, researchers, graduate students) working in areas as diverse as electrical engineering, mechanical and structural engineering, civil engineering, industrial engineering, hydrodynamics, aerospace engineering, microwave and antenna engineering, ocean science and climate modeling, and the automotive industry, where design processes are heavily based on CPU-heavy computer simulations. Various techniques, such as knowledge-based optimization, adjoint sensitivity techniques, and fast replacement models (to name just a few) are explored in-depth along with an array of the latest techniques to optimize the efficiency of the simulation-driven design process. High-fidelity simulation models allow for accurate evaluations of the devices and systems, which is critical in the design process, especially to avoid costly prototyping stages. Despite this and other advantages, the use of simulation tools in the design process is quite challenging due to associated high computational cost. The steady increase of available computational resources does not always translate into the shortening of the design cycle because of the growing demand for higher accuracy and necessity to simulate larger and more complex systems. For this reason, automated simulation-driven design—while highly desirable—is difficult when using conventional numerical optimization routines which normally require a large number of system simulations, each one already expensive.

The four-volume set LNCS 2657, LNCS 2658, LNCS 2659, and LNCS 2660 constitutes the refereed proceedings of the Third International Conference on Computational Science, ICCS 2003, held concurrently in Melbourne, Australia and in St. Petersburg, Russia in June 2003. The four volumes present more than 460 reviewed contributed and invited papers and span the whole range of computational science, from foundational issues in computer science and algorithmic mathematics to advanced applications in

virtually all application fields making use of computational techniques. These proceedings give a unique account of recent results in the field.
This book introduces the latest visual effects (VFX) techniques that can be applied to game programming. The usefulness of the physicality-based VFX techniques, such as water, fire, smoke, and wind, has been proven through active involvement and utilization in movies and images. However, they have yet to be extensively applied in the game industry, due to the high technical barriers. Readers of this book can learn not only the theories about the latest VFX techniques, but also the methodology of game programming, step by step. The practical VFX processing techniques introduced in this book will provide very helpful information to game programmers. Due to the lack of instructional books about VFX-related game programming, the demand for knowledge regarding these high-tech VFXs might be very high.
The main objective of this thesis is the development of an adaptive mesh refinement (AMR) algorithm for computational fluid dynamics simulations using hexahedral and tetrahedral meshes. This numerical methodology is applied in the context of large-eddy simulations (LES) of turbulent flows and direct numerical simulations (DNS) of interfacial flows, to bring new numerical research and physical insight. For the fluid dynamics simulations, the governing equations, the spatial discretization on unstructured grids and the numerical schemes for solving Navier-Stokes equations are presented. The equations follow a discretization by conservative finite-volume on collocated meshes. For the turbulent flows formulation, the spatial discretization preserves symmetry properties of the continuous differential operators and the time integration follows a self-adaptive strategy, which has been well tested on unstructured grids. Moreover, LES model consisting of a wall adapting local-eddy-viscosity within a variational multi-scale formulation is used for the applications showed in this thesis. For the two-phase flow formulation, a conservative level-set method is applied for capturing the interface between two fluids and is implemented with a variable density projection scheme to simulate incompressible two-phase flows on unstructured meshes. The AMR algorithm developed in this thesis is based on a quad/octree data structure and keeps a relation of 1:2 between levels of refinement. In the case of tetrahedral meshes, a geometrical criterion is followed to keep the quality metric of the mesh on a reasonable basis. The parallelization strategy consists mainly in the creation of mesh elements in each sub-domain and establishes a unique global identification number, to avoid duplicate elements. Load balance is assured at each AMR iteration to keep the parallel performance of the CFD code. Moreover, a mesh multiplication algorithm (02) is reported to create large meshes, with different kind of mesh elements, but preserving the topology from a coarser original mesh. This thesis focuses on the study of turbulent flows and two-phase flows using an AMR framework. The cases studied for LES of turbulent flows applications are the flow around one and two separated square cylinders, and the flow around a simplified car model. In this context, a physics-based refinement criterion is developed, consisting of the residual velocity calculated from a multi-scale decomposition of the instantaneous velocity. This criteria ensures grid adaptation following the main vortical structures and giving enough mesh resolution on the zones of interest, i.e., flow separation, turbulent wakes, and vortex shedding. The cases studied for the two-phase flows are the DNS of 2D and 3D gravity-driven bubble, with a particular focus on the wobbling regime. A study of rising bubbles in the wobbling regime and the effect of dimensionless numbers on the dynamic behavior of the bubbles are presented. Moreover, the use of tetrahedral AMR is applied for the numerical simulation of gravity-driven bubbles in complex domains. On this topic, the methodology is validated on bubbles rising in cylindrical channels with different topology, where the study of these cases contributed to having new numerical research and physical insight in the development of a rising bubble with wall effects.
This book presents the refereed proceedings of the Twelfth International Conference on Monte Carlo and Quasi-Monte Carlo Methods in Scientific Computing that was held at Stanford University (California) in August 2016. These biennial conferences are major events for Monte Carlo and quasi-Monte Carlo researchers. The proceedings include articles based on invited lectures as well as carefully selected contributed papers on all theoretical aspects and applications of Monte Carlo and quasi-Monte Carlo methods. Offering information on the latest developments in these very active areas, this book is an excellent reference resource for theoreticians and practitioners interested in solving high-dimensional computational problems, arising in particular, in finance, statistics, computer graphics and the solution of PDEs.
This book constitutes the revised selected papers of the 33rd International Conference on Computer Animation and Social Agents, CASA 2020, held in Bournemouth, UK*, in October 2020. The 1 full paper and 13 short papers presented were carefully reviewed and selected from a total of 86 submissions. The papers are organized in topical sections of modelling, animation and simulation; virtual reality; image processing and computer vision. *The conference was held virtually due to the COVID-19 pandemic.
Part of a four-volume set, this book constitutes the refereed proceedings of the 7th International Conference on Computational Science, ICCS 2007, held in Beijing, China in May 2007. The papers cover a large volume of topics in computational science and related areas, from multiscale physics to wireless networks, and from graph theory to tools for program development.
This book constitutes the refereed proceedings of the 40th German Conference on Pattern Recognition, GCPR 2018, held in Stuttgart, Germany, in October 2018. The 48 revised full papers presented were carefully reviewed and selected from 118 submissions. The German Conference on Pattern Recognition is the annual symposium of the German Association for Pattern Recognition (DAGM). It is the national venue for recent advances in image processing, pattern recognition, and computer vision and it follows the long tradition of the DAGM conference series, which has been renamed to GCPR in 2013 to reflect its increasing internationalization. In 2018 in Stuttgart, the conference series celebrated its 40th anniversary.
This book covers the range of methodological approaches, methods and tools currently used in various areas of building science and technology research and addresses the

current lack of research-method literature in this field. The book covers the use of measurement-based methods in which data is collected by measuring the properties and their variations in actual physical systems, simulation-based methods which work with models of systems or processes to describe, examine and analyze their behaviors, performances and operations, and data-driven methodologies in which data is collected via measurement or simulation to identify and examine the associations and patterns and predict the future in a targeted system. The book presents a survey of key methodologies in various specialized areas of building science and technology research including window systems, building enclosure, energy performance, lighting and daylighting, computational fluid dynamics, indoor and outdoor thermal comfort, and life cycle environmental impacts. Provides advanced insight into the research methods and presents the key methodologies within the field of building science and technology. Reviews simulation-based and experimentation/field-based methods of data collection and analysis in diverse areas of building science and technology, such as energy performance, window and enclosure studies, environmental LCA, daylighting, CFD, and thermal comfort. Provides a range of perspectives from building science faculty and researcher contributors with diverse research interests. Appropriate for use in university courses.

This Festschrift is in honor of Scott A. Smolka, Professor in the Stony Brook University, USA, on the occasion of his 65th birthday. Scott A. Smolka made fundamental research contributions in a number of areas, including process algebra, model checking, probabilistic processes, runtime verification, and the modeling and analysis of cardiac cells, neural circuits and flocking behaviors. He is perhaps best known for the algorithm he and Paris Kanellakis invented for checking bi-simulation. The title of this volume From Reactive Systems to Cyber-Physical Systems reflects Scott's main research focus throughout his career. It contains the papers written by his closest friends and collaborators. The contributions cover a wide spectrum of the topics related to Scott's research scientific interests, including model repair for probabilistic systems, runtime verification, model checking, cardiac dynamics simulation and machine learning.

This thesis focuses on the Lagrangian approach to fluid simulation, its parallelization, and its application in the medical imaging and simulation contexts. The fundamentals of Smoothed Particle Hydrodynamics (SPH) are analyzed, and common implementation techniques are shown. We describe our SPH implementation and show a novel approach to particle-mesh collision resolution. We also focus on the data pre-processing step, so that captured time-varying volumetric heart scans can be directly used to drive the simulation, rather than hand-crafted models. Our new mesh interpolation approach generates intermediate steps to allow stable, higher resolution simulations. Multithreading and GPU parallelism are analyzed, and a multi-CPU approach is shown, which allows the simulation to be highly scalable. We present a visualization framework, VSim, and its application to heart simulations, especially for training, education and collaboration purposes. Additionally, we show the relation between Lagrangian fluids and our previously published work on particle-based hair simulation, and we explore ultrasound volume registration methods with the purpose of enabling blood flow simulations in large volumes.