Plenary Talks

Tuesday, December 8, 09:00
Controlling Swarms of Cooperating Robots

Marco Dorigo
Université Libre de Bruxelles, Belgium

Abstract

Swarm robotics is about constructing and controlling swarms of autonomous robots that cooperate to perform tasks that go beyond the capabilities of the single robots in the swarm. In this talk, I will give an overview of recent and ongoing research in swarm robotics in my research lab, IRIDIA, at the Universit Libre de Bruxelles. In particular, I will present results obtained with homogeneous and heterogeneous swarms of robots that cooperate both physically and logically in search and retrieval tasks.

Biography

Marco Dorigo received his PhD in electronic engineering in 1992 from Politecnico di Milano, Italy, and the title of Agrégé de lEnseignement Supérieur, from Université Libre de Bruxelles (ULB), in 1995. Since 1996, he has been a tenured Researcher of the fund for scientific research F.R.S.-FNRS of Belgiums French Community, and a Research Director of IRIDIA, ULB. He is the inventor of the ant colony optimization metaheuristic. His current research interests include swarm intelligence and swarm robotics. He is the Editor-in-Chief of Swarm Intelligence. Dr. Dorigo is a IEEE, AAAI, and ECCAI Fellow. He was awarded the Italian Prize for Artificial Intelligence in 1996, the Marie Curie Excellence Award in 2003, the Dr. A. De LeeuwDamryBourlart award in applied sciences in 2005, the Cajastur International Prize for Soft Computing in 2007, and an ERC Advanced Grant in 2010. In 2015 he will receive the IEEE Frank Rosenblatt Award.

Wednesday, December 9, 08:30

Large Scale Global Optimisation Through Co-operative Co-evolution

Xin Yao

University of Birmingham, United Kingdom

Abstract

Evolutionary optimisation has moved on in recent years from optimising just a few dozens of real-valued variables, although they are still challenging problems. This talk will give a brief overview of some recent efforts towards large scale global optimisation (LSGO) using co-operative co-evolution. Starting the journey from one of the first efforts in optimising problems with up to 1000 real-valued variables, we illustrate new challenges posed by such problems to evolutionary computation approaches and how co-operative co-evolution could be harnessed to address some of those challenges. Then we focus on one of the key issues in LSGO by co-operative co-evolution — automatic grouping of variables into different co-evolving sub-populations. This is actually a generic and important issue of learning and understanding problem characteristics, especially the interactions among variables. In practice, there is a trade-off to be made between the time we spend on learning problem characteristics and the time we spend on optimisation. Learning makes sense only if the learned information helps to speed up the optimisation more than the time spent on learning. Unfortunately, little is known about the best trade-off. Much work has been based on computational studies, from simple random grouping, which is very fast, to more sophisticated differential grouping, which takes more time in learning. Such grouping methods are not restricted to any particular optimisers used. They can be used in conventional evolutionary algorithms, as well as differential evolution and particle swarm optimisation. Similar ideas are applicable to combinatorial optimisation too. This talk will end with a brief discussion of future research directions and how nature inspiration should be considered in problem-solving, e.g., optimisation.

Biography

Xin Yao is a Professor of Computer Science at the University of Birmingham, UK. His main research interests include evolutionary computation and ensemble learning. He has had a long-term interest in co-evolution since early 1990s, both for optimisation and learning. He has always been keen on framing co-evolution as an automatic approach to divide-and-conquer in problem solving. His recent work on large scale global optimisation (LSGO) started in 2008, covering more "conventional" evolutionary algorithms as well as estimation of distribution algorithms for either numerical or combinatorial optimisation. Closely related to his practical interest in scaling up evolutionary algorithms, he is also interested in time complexity of evolutionary algorithms, i.e., a more theoretical aspect of scalability.

Thursday, December 10, 08:30

Tell Me Something I Don't Know: The Need for Interpretation in Computational Intelligence Models

Paulo Lisboa

Liverpool John Moores University, United Kingdom

Abstract

Computational intelligence (CI) models are often evaluated on the basis of predictive performance, lacking appropriate consideration of other aspects than association which might make a claim to the intelligence of the model. Yet appearances can be deceiving, especially with summary performance measures e.g. AUROC. This is especially the case for non-linear models given their ability to exploit any weaknesses in the data, for instance structural artefacts which add a confounding effect over and above the presence of noise. In addition, many applied CI models work well for well classified cases but cannot explain predictions for borderline cases. In other words, they confirm to expert users what they already know but do not add insights to the data in the difficult cases for which CI is most needed. The talk will illustrate some of the pitfalls in the design and validation of databased models. It will then explore principled approaches to interpreting neural networks usin g theoretical methodologies applied to the often opaque maximal separation models driven by computational learning theory and also probabilistic non-linear models from which the geometry of data spaces can be derived. Some important general questions will be explored including the derivation of nomograms for non-linear models, efficiency and interpretability of rule induction, but also a radically different approach to user interfaces for probabilistic classifiers by deriving statistically principled intelligent query systems for case-based reasoning. These models find particular application in clinical medicine where examples will illustrate tumour delineation and detection of response treatment from brain spectroscopy.

Biography

Paulo Lisboa is Professor in Industrial Mathematics at Liverpool John Moores University and Research Professor at St Helens & Knowsley Teaching Hospitals. He is Fellow of the IMA (Institute of Mathematics & its Applications, UK), Fellow of the IET (Institute of Engineering and Technology, UK) and chair of the Medical Data Analysis Task Force in the Data Mining Technical Committee of the IEEE-CIS. He is on the Advisory Group for Societal Challenge 1: Health, Demographics and Wellbeing in Horizon 2020, the largest coordinated funding programme of health-related research in Europe, which combines medicine and ICT. His research interests are computer-based decision support and data analytics in clinical medicine, public health and sports science, as well as computational marketing. The current focus of interest is on principled approaches to interpret non-linear models. He has over 250 refereed publications with awards for citations and is Associate Editor for IET Science Measure ment and Technology, Neural Computing Applications, Applied Soft Computing and Source Code for Biology and Medicine.

Keynote Talks

Tuesday, December 8, 10:20

Statistical Simulation Algorithms for General Video Game AI

Simon Lucas

University of Essex, United Kingdom

Abstract

Monte Carlo Tree Search (MCTS) has revolutionised AI for classic board games such as Go, and more recently has been applied with some promising results to controlling agents in real-time video games. Where a forward model that can be run much faster than real-time is available, this can be applied to build game agent controllers that can operate across a variety of games with out being specifically programmed for any particular game.

Recently it has been shown that evolutionary algorithms applied in a rolling horizon way, much like MCTS, can achieve similar performance while perhaps being simpler to implement and easier to adapt. Some of the problems involved with real-time agents (including massive branching factors, limited horizon depth, limited roll-out budget and flat reward landscape) will be covered together with possible outline solutions.

The talk will also report on the General Video Game AI Competition series which offers a way to objectively compare these algorithms across a variety of games and implemented by a diverse set of researchers (see http://gvgai.net), and offers a great challenge for computational intelligence research.

Biography

Simon Lucas is a professor of Computer Science in the School of Computer Science and Electronic Engineering at the University of Essex (UK) where he is the Head of School and leads the Game Intelligence Group. He holds a PhD degree (1991) in Electronics and Computer Science from the University of Southampton. His main research interests are games, evolutionary computation, and machine learning, and he has published widely in these fields with over 180 peer-reviewed papers. He is the inventor of the scanning ntuple classifier, is the founding Editor-in-Chief of the IEEE Transactions on Computational Intelligence and AI in Games and co-founded the IEEE Conference on Computational Intelligence and Games. His main research area now is developing and applying computational intelligence techniques to build better game AI, better games, and provide deep insights into the nature of intelligence.

Tuesday, December 8, 11:00

Valuing American Options using Fast Recursive Projections

Olivier Scaillet

Université de Genève and Swiss Finance Institute, Switzerland

Abstract

This keynote introduces a new numerical option pricing method by fast recursive projections. The projection step consists in representing the payoff and the state price density with a fast discrete transform based on a simple grid sampling. The recursive step consists in transmitting coefficients of the representation from one date to the previous one by an explicit recursion formula. We characterize the convergence rate of the computed option price. Numerical illustrations with different American and Bermudan payoffs with discrete dividend paying stocks in the Black-Scholes and Heston models show that the method is fast, accurate, and general. We apply our recursive projection method with the models of Black-Scholes, Merton and Heston on a sample of call options on stocks with quarterly dividends during the period January 1996 through December 2012. We illustrate that the choice of the model is important for both the early exercise decision and for the quantification of the dollar amount that the buyer of the option forgoes when he fails to optimally exercise to the advantage of the seller.

Biography

Olivier Scaillet, Belgian, is professor of finance and statistics at the Geneva Finance Research Institute of the University of Geneva and has a senior chair at the Swiss Finance Institute. He holds both a master and Ph.D. from University Paris IX Dauphine in applied mathematics. Professor Scaillet's research expertise is in the area of derivatives pricing, econometric theory and econometrics applied to finance and insurance. He has published several papers in top journals in econometrics and finance, and co-authored a book on financial econometrics. He has been one of the winners of the bi-annual award for the best paper published in the Journal of Empirical Finance on the topic of quantitative risk management and of the Banque Prive Espirito Santo award prize on the topic of mutual fund performance. He is associate editor of several leading academic journals in econometrics, statistics, banking and finance. He is an advisor for research teams in the finance and banking industry.

Tuesday, December 8, 13:00

Structure Metric Learning in Prototype-based Models and Its Application for Intelligent Tutoring

Barbara Hammer

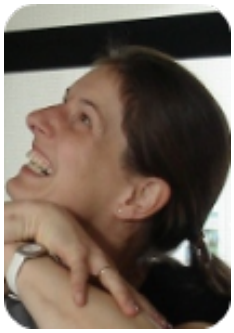
CITEC Centre of Excellence, Bielefeld University, Germany

Abstract

Prototype-based learning techniques enjoy a wide popularity due to their intuitive training and model interpretability. Applications include biomedical data analysis, image classification, or fault detection in technical systems. Recently, first promising attempts incorporate such models into the domain of intelligent tutoring systems (ITS): in a nutshell, ITSs provide automated, personalised feedback to learners when performing some learning task such as learning how to program. Here a challenge is to avoid time-consuming expert generation of how to provide such feedback; machine learning technology offers promising ways to automate this process, specifically, prototype-based methods enable an automatic feedback generation by highlighting prototype solutions given a learner solution. This strategy relies on the core property of such models that they represent data in terms of typical representatives. Within the talk, we will mainly focus on modern variants of so-called learning vector quantization (LVQ) due to their strong learning theoretical background and exact mathematical derivative from explicit cost functions.

The use of LVQ in ITSs faces two challenges: 1) Data are typically non-vectorial, e.g. structured data such as sequences are present; since classical LVQ models have been designed for euclidean vectors only, the question is how to extend LVQ technology towards non-vectorial data. We will present relational extensions of LVQ technology which enable its use for proximity data as provided by structure metrics such as alignment in a very generic way. 2) Structure metrics crucially depend on model parameters such as the scoring function, and their optimum choice is not clear. Still, the accuracy of such models crucially depends on a correct choice of these metric parameters. We will present recent results which allow to adjust structure metric parameters autonomously based on the given data and learning task only.

Biography



Barbara Hammer received her Ph.D. in Computer Science in 1995 and her venia legendi in Computer Science in 2003, both from the University of Osnabrueck, Germany. From 2000-2004, she was chair of the junior research group 'Learning with Neural Methods on Structured Data' at University of Osnabrueck before accepting an offer as professor for Theoretical Computer Science at Clausthal University of Technology, Germany, in 2004. Since 2010, she is holding a professorship for Theoretical Computer Science for Cognitive Systems at the CITEC cluster of excellence at Bielefeld University, Germany. Several research stays have taken her to Italy, U.K., India, France, the Netherlands, and the U.S.A. Her areas of expertise include hybrid systems, self-organizing maps, clustering, and recurrent networks as well as applications in bioinformatics, industrial process monitoring, or cognitive science. She has been chairing the IEEE CIS Technical Committee on Data Mining in 2013 and 2014, and she is chair of the Fachgruppe Neural Networks of the GI and vice-chair of the GNNS. She has published more than 200 contributions to international conferences / journals, and she is coauthor/editor of four books.

Tuesday, December 8, 13:40

Impact of Big Data on Computational Intelligence Aspects of Cyber Security and the Computing Environment to Support Repeatable Scientific Experimentation

Robert Abercrombie

Oak Ridge National Laboratory (ORNL), Oak Ridge, USA

Abstract

Big Data is being generated by everything around us at all times. Every digital process and social media exchange produces it. Systems, sensors and mobile devices transmit it. Big data is arriving from multiple sources at an alarming velocity, volume and variety. To extract meaningful value from big data, todays scientists need optimal processing power, analytics capabilities and skills. Advances in information and communications technologies (ICT) have transformed the way citizens, business, and governments interact, collaborate, and conduct business. ICT form the backbone of many aspects of the critical infrastructure sectors, particularly in technologically advanced countries. The interdependencies between critical infrastructure sectors in one or more countries can potentially lead to large-scale (or global) systemic failures, resulting in loss of human life and social unrest. Securing our cyberspace and critical infrastructure (a nations strategic national assets) is important in order to ensure economic growth, prosperity, and safety; and is recognized as one of the great Grand Challenges and will continue to be of importance in the foreseeable future. This process must have scientific rigor applied to it to ensure a repeatable proven successful solution. ICT security has become a business priority. The US government recognized this as evidenced by recent significant budget increases in cyber security. Business organizations are investing enormous resources (money, time and human capital) in security activities. A principal tenant of the scientific method is that experiments must be repeatable and relies on ceteris paribus (i.e., all other things being equal). As a scientific community, involved in data sciences and cyber security, researchers must investigate ways to establish an environment where experiments can be repeated. We can no longer allude to where the data comes from, we must add rigor to the data collection and management process from which our analysis is conducted. This keynote describes a computing environment to support repeatable scientific big data experimentation, in order to provide value to investigators from government agencies, academic institutions, and industry entities. The described computing environment also adheres to the recently instituted digital data management plan mandated by multiple US government agencies, which involves all stages of the digital data life cycle including capture, analysis, sharing, and preservation. It particularly focuses on the sharing and preservation of digital research data. This keynote supports the theme of 2015 IEEE CICS in that Computational Intelligent (CI) techniques have demonstrated to enhance cyber security measures, and have been increasingly applied in the area of information security and information assurance. Moreover, the multi-faceted CI approaches are beginning to provide a new security paradigm to deal with influx of new threats in a large network of computers. These approaches can also be used to augment defense-in-depth architectures and to add necessary security enhancements to the design, implementation and operation of legacy and future cyber-enabled systems.

Biography

Robert (Bob) K. Abercrombie is Co-Director, Computational Intelligence Behavior Modeling Laboratory, S&T Manager in the Computational Sciences and Engineering Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN USA. Additionally he has a joint faculty appointment with the Graduate School and Department of Computer Science, The University of Memphis, collaborating with the Center for Information Assurance, the Center for Earthquake Research and Information and the Systems Testing Excellence Program. He is also Program Manager/Principal Investigator at ORNL with extensive experience in all phases of program and project life cycle management from requirements definition through retirement and closeout of system. Additional interests include technical management of R&D multi-disciplinary complex endeavors, their supply chain management and associated cyber security related endeavors. He has previously conducted research and managed military, government and civilian projects dealing the characterization of vehicles and associated cargo. In recent years, his research interests and endeavors include cyber security and information

assurance technologies in secure environments and transitioning this research to the private sector via ORNL technology transfer process. Current research efforts deal with developing break-through approaches for analytic capabilities that work across heterogeneous data sets and addressing the necessary computational intelligence techniques to address cyber security, big data analytics, and applications of theories of emergence.
Dr. Abercrombie is a Senior Member of IEEE, Senior Member of IEEE Computational Intelligence Society, Senior Member, IEEE Computer Society, Member of ACM, and Founding Member of International Society for Weigh-In-Motion (ISWIM).

Tuesday, December 8, 14:20

Cognitive Robotics: Recent Developments and Futuristic Trends

Er Meng Joo

Nanyang Technological University, Singapore

Abstract

The quest for building human-like intelligence has gained enormous momentum in recent decades. Since the seminal works on Artificial Intelligence (AI), the desire of realizing the quest has become stronger. With the rapid developments in Science, Engineering and Technology, machines that mimic human intelligence have become a reality and sometimes indispensable parts in our daily life, such as Apple Siri and Google Voice. Cognition is a group of mental processes that include attention, memory, producing and understanding language, solving problems and making decisions and making decisions. Cognitive robotics is concerned with endowing robots with intelligent behavior by providing a processing architecture that will allow it to learn and reason about how to behave in response to complex goals in a complex world. In this talk, recent developments of cognitive robotics with applications in the healthcare industry, domestic services, etc will be reviewed. The futuristic trends and challenges will also be discussed.

Biography

Professor Er Meng Joo is currently a Full Professor in Electrical and Electronic Engineering, Nanyang Technological University, Singapore. He has authored 5 books, 16 book chapters and more than 500 refereed journal and conference papers in his research areas of interest. His areas of research interests are Intelligent control theory and applications, computational intelligence, robotics and automation, sensor networks, biomedical engineering and cognitive science.
In recognition of the significant and impactful contributions to Singapores development by his research project entitled Development of Intelligent Techniques for Modelling, Controlling and Optimizing Complex Manufacturing Systems, Professor Er won the Institution of Engineers, Singapore (IES) Prestigious Engineering Achievement Award 2011. He is also the only dual winner in Singapore IES Prestigious Publication Award in Application (1996) and IES Prestigious Publication Award in Theory (2001). He received the Teacher of the Year Award for the School of EEE in 1999, School of EEE Year 2 Teaching Excellence Award in 2008, the Most Zealous Professor of the Year Award 2009 and Outstanding Mentor Award 2014. He also received the Best Session Presentation Award at the World Congress on Computational Intelligence in 2006 and the Best Presentation Award at the International Symposium on Extreme Learning Machine 2012. Under his leadership as Chairman of the IEEE CIS Singapore Chapter from 2009 to 2011, the Singapore Chapter won the CIS Outstanding Chapter Award 2012. In recognition of his outstanding contributions to professional bodies, he was bestowed the IEEE Outstanding Volunteer Award (Singapore Section) and the IES Silver Medal in 2011. On top of this, he has more than 50 awards at international and local competitions. Currently, Professor Er serves as the Editor-in-Chief of 2 international journals, namely the Transactions on Machine Learning and Artificial Intelligence and International Journal of Electrical and Electronic Engineering and Telecommunications, an Area Editor of International Journal of Intelligent Systems Science, an Associate Editor of thirteen refereed international journals including the IEEE Transaction on Fuzzy Systems and IEEE Transactions on Cybernetics as well as an editorial board member of the EE Times. Professor Er is a highly sought-after speaker and he has been invited to deliver more than 60 keynote speeches and invited talks overseas. Due to outstanding achievements in research and education, he is listed in Whos Who in Engineering Singapore, Second Edition, 2013.

Wednesday, December 9, 09:50

Planning and Scheduling Models in Intermodal Transport Optimization

Erwin Pesch

University of Siegen, Germany

Abstract

Attracting a higher share of freight traffic on rail requires freight handling in railway yards that is more efficient, and which includes technical innovations as well as the development of suitable optimization approaches and decision-support systems. In this talk we will review some planning and scheduling problems of container processing in railway yards, and analyze basic decision problems and solution approaches for the two most important yard types: conventional rail road and modern rail -rail transshipment yards. We introduce new matching problems that generalize container assignment in railway yards and sea ports. Furthermore, we review some of the relevant literature and identify open research challenges. Additionally we address a scheduling problem that arises in intermodal container transportation, where containers need to be transported between shipper or receiver customers and container terminals (rail or maritime) and vice versa. The solution method can be applied to other problems as well.

Biography

Erwin Pesch holds a Chair in Management Information Sciences at the University of Siegen. He was employed as a Software Engineer at the Commerzbank AG and worked from 1989 to 2001 as an Assistant Professor at the Faculty of Economics and Business Administration of the University in Maastricht and as a Professor at the Institute of Economics of the University in Bonn. He holds a Ph.D. in Mathematics and a Habilitation in Business Administration both from the Technical University Darmstadt. His research areas are in Logistics, Management Information and Decision Support Systems, Project Management and Scheduling many of which are closely related to various industrial projects. He is author or co-author of 5 books and has published more than 150 papers in many international journals, among others in Mathematical Programming, Artificial Intelligence, Management Science, Journal of Combinatorial Theory, Journal of Graph Theory, IEEE Transactions on Robotics and Automation, Discrete Mathematics, Discrete Applied Mathematics, and serves on the editorial boards of 12 international journals including INFORMS Journal on Computing, Journal of Scheduling, European Journal of Operational Research, Operations Research Letters. He received many Federal Grants from the German National Science Foundation (DFG) and for more than 10 years always achieved leading positions in citation analysis and publication based rankings in German speaking countries. In 2008 he got the Award of the Polish Minister for Research and Education and obtained the prestigious Copernicus Award (with J. Blazewicz) in 2012.

Wednesday, December 9, 10:30
Complex Behaviour in Artificial Life

Terry Bossomaier
Charles Sturt University, Australia

Abstract

Artificial Life systems frequently display, interesting dynamic behaviour. An early example was Conways Game of Life. Reynolds flocking of boids introduced coherent flock dynamics from simple rules. However, finding metrics for such complex dynamical behaviour has proved illusive. Information theory has shown a lot of promise since Langtons original work on cellular automata. This talk will review its application across a range of ALife systems, from networks to flocking behaviour.

Biography

Terry Bossomaier is the Strategic Research Professor in the Faculty of Business at Charles Sturt University. His research interests are very diverse, ranging from vision to high performance computing. He co-founded the Asia-Pacific Complex Systems conferences, which have run biennially since the early 90s. At Charles Sturt University he set up the Centre for Research in Complex Systems (CRiCS) and has run a series of complex systems research summer schools since 1998. His current research interests focus on the agent based modelling of socio economics systems and information-theoretic approaches to studying tipping points. He has published numerous articles range of fields from biological vision to high performance and parallel computing and is a co-author/editor of five books and is just completing a book on information flow in complex systems.

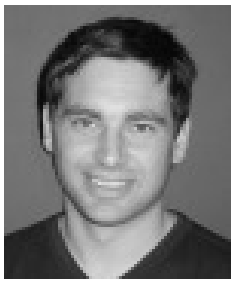
Wednesday, December 9, 11:10
Automation vs Intuition in MCDM

Joshua Knowles
University of Birmingham, United Kingdom

Abstract

Advances in the automatic design and configuration of optimisation algorithms show great promise in improving algorithm evaluation and comparison, as well as producing methods that users (e.g. in industry) can be confident are tuned. In this talk, I will consider the extension of this trend to interactive multiobjective algorithms steered by (human) decision-makers. How should we automate the process of tuning these without the need for human DMs to help? And if we succeed what are the next challenges to human intuition in algorithm design and the practice of MCDM?

Biography



Joshua Knowles is Professor of Natural Computation at the School of Computer Science, University of Birmingham, UK. He graduated with a PhD from University of Reading, UK, in 2002, following degrees in Physics, and Information Systems Engineering.
Professor Knowles main research interests are computational intelligence, multiobjective optimization, and expensive black-box problems. He is known for early EMO work especially developing the PAES algorithm (with David Corne) and the technique 'multiobjectivization' (with Richard Watson and David Corne), and more recently the ParEGO algorithm for expensive multiobjective problems, and MOCK (with Julia Handl) a powerful multiobjective clustering and model selection method. Joshua's applied work, mostly in computational biochemistry, has included the optimization of analytical instruments, evolution of combinatorial drug therapies, and the directed evolution of DNA 'aptamers' (all done with physical experiments in the optimization loop). To date, he has published approx.120 articles in conferences, journals and books, attracting over 12,500 citations (h-index=51).
Professor Knowles has twice won the annual Outstanding Paper Award of the Transactions on Evolutionary Computation from IEEE Computational Intelligence Society, as well as fellowships from BBSRC and the European Commission. He is an editorial board member of Evolutionary Computation journal, co-chair of the 2015 Dagstuhl Seminar on Understanding Complexity in Multiobjective Optimisation, and a member of the Steering committee of the EMO series of international conferences.

Wednesday, December 9, 13:00

Motor Skill Learning: From Simple Skills to Table Tennis and Manipulation

Jan Peters

Max Planck Institute for Intelligent Systems, Germany

Abstract

Autonomous robots that can assist humans in situations of daily life have been a long standing vision of robotics, artificial intelligence, and cognitive sciences. A first step towards this goal is to create robots that can learn tasks triggered by environmental context or higher level instruction. However, learning techniques have yet to live up to this promise as only few methods manage to scale to high-dimensional manipulator or humanoid robots. In this talk, we investigate a general framework suitable for learning motor skills in robotics which is based on the principles behind many analytical robotics approaches. It involves generating a representation of motor skills by parameterized motor primitive policies acting as building blocks of movement generation, and a learned task execution module that transforms these movements into motor commands. We discuss learning on three different levels of abstraction, i.e., learning for accurate control is needed to execute, learning of motor primitives is needed to acquire simple movements, and learning of the task-dependent hyperparameters of these motor primitives allows learning complex tasks. We discuss task-appropriate learning approaches for imitation learning, model learning and reinforcement learning for robots with many degrees of freedom. Empirical evaluations on a several robot systems illustrate the effectiveness and applicability to learning control on an anthropomorphic robot arm. These robot motor skills range from toy examples (e.g., paddling a ball, ball-in-a-cup) to playing robot table tennis against a human being and manipulation of various objects.

Biography

Jan Peters is a full professor (W3) for Intelligent Autonomous Systems at the Computer Science Department of the Technische Universitaet Darmstadt and at the same time a senior research scientist and group leader at the Max-Planck Institute for Intelligent Systems, where he heads the interdepartmental Robot Learning Group. Jan Peters has received the Dick Volz Best 2007 US PhD Thesis Runner-Up Award, the Robotics: Science & Systems - Early Career Spotlight, the INNS Young Investigator Award, and the IEEE Robotics & Automation Societys Early Career Award. In 2015, he was awarded an ERC Starting Grant. Jan Peters has studied Computer Science, Electrical, Mechanical and Control Engineering at TU Munich and FernUni Hagen in Germany, at the National University of Singapore (NUS) and the University of Southern California (USC). He has received four Masters degrees in these disciplines as well as a Computer Science PhD from USC.

Wednesday, December 9, 13:40

Computational Intelligence Based Controllers for Real-Time Control in Power Systems

Om Malik

University of Calgary, Canada

Abstract

Conventional and linear optimal controllers are based on the deterministic control theory. They are designed using a linear system model obtained for a particular operating condition. The non-linear nature, wide range of operating conditions and the non-deterministic properties of most large systems, such as power systems, present problems to the conventional controllers. Adaptive control theory offers an approach to design a controller that can mitigate these problems. Developments in digital technology have made it feasible to develop and implement improved controllers based on modern more sophisticated techniques. The strength of this approach will be illustrated using power system stabilizer as an application example. Design of controllers based on computational intelligence techniques, such as neural networks and fuzzy logic, will be described. The performance of such controllers by both simulation studies on single machine and multi-machine power systems, and real-time tests on physical models of single machine-infinite bus systems will also be illustrated.

Biography

Professor Om P. Malik has done pioneering work in the development of controllers for application in electric power systems and wind power generation over the past 45 years. After extensive testing, these controllers are now employed on large generating units. He has published over 700 papers including over 360 papers in international Journals and is the coauthor of two books. Professor Malik graduated in 1952 from Delhi Polytechnic. After working for nine years in electric utilities in India, he obtained a Masters Degree from Roorkee University in 1962, a Ph.D. from London University and a DIC from the Imperial College, London in 1965. He was teaching and doing research in Canada from 1966 to 1997 and continues to do research as Professor Emeritus at the University of Calgary. Over 100, including 45 Ph.D., students have graduated under his supervision. Professor Malik is a Life Fellow of IEEE, and a Fellow of IET, the Engineering Institute of Canada, Canadian Academy of Engineering, Engineers Canada and World Innovation Foundation. He is a registered Professional Engineer in Alberta and Ontario, Canada, and has received many awards. He was Director, IEEE Region 7 and President, IEEE Canada during 2010-11. Currently, he is President, Engineering Institute of Canada.

Wednesday, December 9, 14:20

Evolutionary Design for Approximate Computing: Trading Accuracy for Energy Efficiency and Performance in Circuits and Programs

Lukas Sekanina

Brno University of Technology, Czech Republic

Abstract

Approximate computing is a new design paradigm emerging as a response to the growing need for performance and energy efficiency of computing systems. It exploits the fact that the requirement of perfect functional behavior can be relaxed in some applications because they are inherently error resilient (consider, for example, multimedia and data mining applications). The error can be used as a design metric and traded for area, delay, throughput or power consumption. An open question is how to systematically approximate hardware (electronic circuits) and software. Evolutionary computing (EC) seems to be a promising method in this area because it is capable of delivering efficient circuit designs in terms of a multi-objective design scenario, where circuits displaying the best tradeoff among key parameters are automatically sought. This talk will present some EC-based methods developed to digital circuit approximation. We will also deal with the scalability problems of evolutionary circuit design and present methods (based on formal verification and various acceleration techniques) enabling us to evolve/approximate complex digital circuits. Finally, we will discuss the relation between genetic improvement and approximation of software.

Biography

Lukas Sekanina received the Ing. and Ph.D. degrees from Brno University of Technology, Brno, Czech Republic, in 1999 and 2002, respectively. He is a Full Professor with the Faculty of Information Technology, Brno University of Technology. His research interests include evolutionary design, evolvable hardware and approximate computing. In these areas, he co-authored over 150 papers. He received a Fulbright Scholarship to work with NASA Jet Propulsion Laboratory, Caltech, USA, in 2004. He was a visiting professor with Pennsylvania State University, USA in 2001, Universidad Politecnica de Madrid, CEI, Spain in 2012 and a visiting researcher with the University of Oslo, Norway, in 2001. He was an Associate Editor of IEEE Transactions on Evolutionary Computation and an Editorial Board Member of Genetic Programming and Evolvable Machines and International Journal of Innovative Computing and Applications. He is a senior member of IEEE.

Thursday, December 10, 09:50

Monte Carlo Tree Search

Tristan Cazenave

Dauphine Universite Paris, France

Abstract

Monte Carlo Tree Search is a family of algorithms that improved greatly the state of the art in multiple games and optimization problems. This talk will address its application to games such as Go and General Game Playing. Nested Monte Carlo Search is a related algorithm for optimization problems. We will describe how it broke world records for puzzles, mathematical problems and expression discovery.

Biography

Tristan Cazenave is professor of computer science at LAMSADE, University Paris-Dauphine. He does research in Artificial Intelligence for games and optimization using Monte Carlo Tree Search and heuristic search.

Thursday, December 10, 10:30
Computational Intelligence in Smart Grids

Ralf Mikut

Karlsruhe Institute of Technology, Germany

Abstract

Future energy systems will be characterized by an increasing proportion of fluctuating renewable energy sources, including solar and wind energy. As an example, the German energy master plan called "Energiewende" assumes a share of more than 80% of renewable power generation until 2050. This requires a complete redesign of the energy system with steps to a closer integration of different types of energy (power, gas, heat, steam etc.), the use of storage and conversion strategies, new policies and market designs, demand-side and demand-response strategies to influence the consumption behavior, and an increasing decentralization of generation and storage. To guarantee a stable and reliable behavior of such systems, the stepwise launching of so-called smart grids was proposed to collect and exploit information of decentralized generation, consumption, transmission and storage units. To establish smart grids, some existing grids have been equipped with smart meter technology and/or experimental market policies and further projects addressing different aspects and scales are in the planning and implementation phase. Such smart grids have started collecting large datasets, mainly in form of time series with different sampling periods. Modeling approaches include first principle methods based on physical knowledge (e.g., for wind farms) as well as data-driven approaches based on meteorological forecasts and smart grid time series. The models are needed for understanding the underlying systems and for short- and midterm predictions as part of optimization and control algorithms to balance energy generation, consumption, and storage in decentralized systems. Computational Intelligence (CI) approaches including fuzzy clustering, Artificial Neural Networks, and Evolutionary Algorithms are strong candidates to support data-driven modeling and forecasts as well as many decentralized optimization tasks. The aim of this plenary talk is to give a survey of future trend scenarios of smart grids with a special focus on data-driven modeling with CI approaches. In addition, personal experiences will be highlighted in the analysis of terabyte-scale smart meter datasets with high time resolution in the kHz range, in the modeling of demand response strategies using fuzzy clustering and regressions methods, and in the prediction of price-influenced load changes. Finally, publicly available datasets such as smart meter data from Olympic Peninsula Project1, phasor measurement units from the EPFL Lausanne in Switzerland2 and solar power data from the Ausgrid Solar Home Electricity Data3 will be discussed to encourage the CI community to apply and to improve algorithms in the scope of this emerging field of research.

Biography

Ralf Mikut is head of the group for Automated Image and Data Analysis at the Institute for Applied Computer Science and Professor at the Faculty for Mechanical Engineering at the Karlsruhe Institute of Technology (KIT), Germany. In addition, he is responsible for the Topic "Big Data" in the "Energy Lab 2.0" project sponsored by the Helmholtz Association, the German Federal Ministry of Education and Research (BMBF) and the Ministry of Science, Research and Art (MWK) of the State of Baden-Württemberg in Germany. He holds a masters degree in Automatic Control of TU Dresden and a Ph.D. degree and Habilitation degree in Mechanical Engineering from the University of Karlsruhe.

Prof. Mikut co-authored 69 peer-reviewed journal papers as well as numerous book chapters and conference papers. His research interests include general and customized Computational Intelligence, data mining and image processing algorithms for a wide range of applications from life sciences to engineering. He is Associate Editor of IEEE Transactions on Fuzzy Systems, editorial board member of the German journal at-Automatisierungstechnik. In addition, he was program committee member of FUZZ-IEEE, IEEE SSCI, SMPS and PPSN conferences and Chair of the Expert Committees "Fuzzy Control" and "Computational Intelligence" of the German Society for Measurement and Automatic Control.

Thursdau, December 10, 11:10

Evolutionary Ensemble Learning in Uncertain Environments

Ke Tang

University of Science and Technology of China, China

Abstract

Evolutionary algorithms (EAs) have been long believed to have great potential for ensemble learning, as a base learner of an ensemble can be naturally viewed/regarded as an individual of the population of an EA. Previous applications of EAs to ensemble learning are largely focused on relatively traditional learning tasks, e.g., classification problems for which the prior distribution of classes are fixed and balanced. This talk will introduce our recent progress on utilizing EAs to construct classifier ensembles for problems with uncertain (likely to be imbalanced) class prior distributions and even uncertain misclassification costs. Specifically, with the Receiver Operating Characteristic (ROC) analysis as a bridge, we will show that a number of Multi-Objective evolutionary approaches outperform the state-of-the-art methods from the machine learning area on this family of problems.

Biography

Ke Tang is currently a Full Professor at the School of Computer Science and Technology, University of Science and Technology of China. He has authored/co-authored more than 100 refereed publications. His major research interests include evolutionary computation and machine learning. He has been conducting research on ensemble learning for more than 10 years. He is an Associate Editor or Editorial Board Member of the IEEE Computational Intelligence Magazine, Computational Optimization and Applications (Springer), Natural Computing (Springer) and Memetic Computing (Springer). He has also served for seven international conferences as program/technical chair/co-chair, including the IEEE CEC2010 and IEEE CEC2013. He is a member of the IEEE Computational Intelligence Society (CIS) Evolutionary Computation Technical Committee and the IEEE CIS Emergent Technologies Technical Committee.

Thursday, December 10, 14:00

Frontiers in Complex Engineering Optimization – The System-by-design Paradigm

Andrea Massa

Eledia Research Center, University of Trento, Italy

Abstract

The design of real-world complex engineering systems has recently shifted from ad-hoc strategies based on the designers experience to optimization based search methods. The introduction of such techniques has been enabled by the availability of huge computational resources as well as the existence of efficient simulation tools that reliably evaluate the quality of the guess solutions. Nevertheless, several synthesis problems still remain computationally intractable (i.e., their optimization through iterative procedures requires months/years). Moreover, this class of problems is becoming more and more important because of increasing demand for advanced systems operating across different scales (e.g., combining nano- to macro-scale) and involving multiple disciplines (e.g., physics, engineering, cognitive sciences). In this framework, the aim of this Talk is to discuss the fundamental engineering challenge of the curse of dimensionality in complex systems design and to present a new general-purpose and flexible engineering optimization paradigm, namely the System-by-Design (SbD). The foundations of this paradigm are the description of a complex system in terms of a set of hierarchical layers (e.g., architecture, geometry, material, etc.), the identification of the degrees-of-freedom (DoFs) of each layer, and the customization and development of suitable synthesis tools able to exploit these DoFs in an effective and computationally efficient way.

Biography

Andrea Massa received the M.S. and the Ph.D. degrees in EECS from the University of Genoa, Italy, in 1992 and 1996, respectively. Assistant Professor at the University of Genoa (1997-1999), Associate Professor (2001-2004) and Full Professor (2005-today) of Electromagnetic fields at the University of Trento. His research activities are mainly concerned with direct and inverse scattering problems, antenna systems and large arrays, radars architectures and processing, WSNs, semantic wireless technologies, system-by-design/materials-by-design (meta-materials and reconfigurable materials), and theory/applications of optimization techniques to engineering problems.

At present, Prof. Massa is the Director of the ELEDIA Research Center located in Trento with offshore labs in Paris, Nagasaki, and Addis Ababa. Moreover, he is holder of a Senior DigiTEo Chair at SUPLEC (France) and Adjunct Professor at Penn State University (USA). He has been Visiting Professor at the Missouri University of Science and Technology (USA), the NUS (Singapore), the Nagasaki University (Japan), the University of Paris Sud (France), and the Kumamoto University (Japan). Prof. Massa serves as AE of the IEEE-TAP, member of the Editorial Board of the JEMWA, a permanent member of the "PIERS Technical Committee" and of the "EuMW Technical Committee", and an ESoA member.

Prof. Massa published more than 600 scientific publications among which more than 260 on international journals and about 360 in international conferences where he presented more than 50 invited contributions. He has organized 45 scientific sessions in international conferences and has participated to several technological projects in the European framework (20 EU Projects) as well as at the national and local level with national agencies (75 Projects/Grants).