Error modelling in Origami constructions

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From boxes and airbags to solar shields and metamaterials, folding is a fundamental manufacturing process. It plays an important role in the functionality of many of the objects we encounter on a daily basis. Recently, the field of Origami science has received significant interest; new innovative applications utilising these ancient techniques are now becoming common place. The underlying mathematical principles of folding have been explored, however, error modelling for the purpose of error reduction has not. In both Origami as an art form and its applications, accuracy and precision play a key role in the aesthetics and functionality of the finished product. Our work provides several novel approaches for minimising errors in Origami constructions. We show it is possible to reduce errors by simply changing the way instructions are presented or by changing the order of instructions.

There are multiple instructions that lead to the same crease, we will present a mathematical model to show which method will most likely lead to the fold with highest precision. Looking at Origami constructions from the ground up we introduce a margin of error to an alignment and model each of the one-fold Huzita-Justin Axioms. From this we can show the factors that most affect how precisely a fold is made. Expanding beyond this, we explore how errors made in one crease affect the formation of subsequent creases. We show there are creases in which errors have a greater impact on the final result than others and how; by changing the order of instructions, we can create the same end product with a greater precision.

We provide two methods to apply these results. Firstly, a simple method which minimises the number of dependant layers of constructions for all creases in a given crease pattern. Secondly, a more in depth calculation of which alignments should be made where there is a choice for any given step.

A new data compression method (yes-no-yes Bloom filters) and ways of optimising its performance

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Abstract: Bloom filters (and many variations of Bloom filters) are data compression methods designed for representing sets. As a simple example, think of a black-and white drawing; it consists of a relatively small number of black pixels surrounded by the background consisting of white pixels. We can store the drawing in a compressed form by representing the set of black pixels with a Bloom filter. Using Bloom filters is both space-efficient and time-efficient. However, Bloom filters produce errors, namely, false positives: that is, to use our example, when you reconstitute the drawing from its Bloom filter, the result will probably contain more black pixels than the original drawing. Therefore, much research was conducted trying to reduce the number of errors in Bloom filters. Our team studied several variations of Bloom filters which have better accuracy than original Bloom filters. Moreover, our variations of Bloom filters contain parameters which can be adjusted to minimise the number of errors. We used this problem as a sample optimisation problem and applied several optimisation techniques to it.

Inpainting large missing regions based on Seam-Carving

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Abstract An inpainting algorithm is developed to recover missing image information's and shows promising results. Existing inpainting approaches include partial differential equations based inpainting (PDE-BI) and exemplar-based inpainting (EBI). PDE-BI techniques have been used to fill in the information in the missing region via information propagation from the missing region's neighbouring areas, pixel by pixel. However, it can only reconstruct successfully small missing regions that are surrounded by little or no texture. EBI techniques on the other hand, are used to recover large missing regions with richly-textured and/or structured areas around them. The EBI approach succeeded in simultaneously building texture and structure in the missing regions using information from the surrounding patches. However, artefacts are likely to occur during the recovery of large missing regions in EBI algorithm. To overcome this defect, this paper proposes a method to reduce the size of missing region by using ***seam carving*** approach which enables EBI and PDE-BI algorithm to recover large missing region. Seam-carving resizes images based on content-awareness of the image for both reduction and expansion without affecting those regions of the image which have rich information. In our proposal, seam carving method is used to reduce only the size of the missing region, to be subsequently recovered by using EBI method. Afterwards, the image is resized back to its original size by adding the seams removed in the first step. Finally, the added extra paths resulting from the added seams will be repaired by using PDE-BI. The results of using a seam-carving method with multi-inpainting algorithms outperform the state-of-art EBI approaches.

A Novel, Robust and Adaptive Model for Predicting Oral Drugs Absorption

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Abstract

Background

We analyse and compare the performance of several deterministic models used to simulate drug absorption via extravascular uptake: the standard lag time model (LAG), the transit compartment model (TCM) and the discrete delay differential equation (DDE) model. We then propose key modifications to the TCM to improve its performance and reduce the number of unknown parameters. In addition, we extend the discrete DDE model to include time delay in both the absorption and *clearance* phase, which gives the system better curve fitting functionality. Further, we enhance the adaptability and robustness of the modified models by incorporating some theoretical approaches to systematically evaluate an initial guess of the underlying pharmacokinetic parameter estimates. The goodness-of-fit was assessed by inspection of diagnostic graphs, the decrease of the objective function value and by direct comparison with results from the Simbiology toolbox (MathWorks Inc., Natick, Massachusetts, USA) and their associated statistics.

Results

The complex absorption process of an oral dosage is predicted with greater precision and minimal user intervention. We observe that the optimisation is greatly enhanced by a priori information about PK parameter estimates, which induces further precision in the performance of the derivative-free optimisation method used and reduces consequential numerical difficulties. The modified models demonstrate more robustness against a wide variety of data. In particular we show that the modified discrete DDE model is significantly more robust than the LAG, TCM, modified TCM and discrete DDE models.

Conclusions

Based on these results, the modified discrete DDE model is an attractive alternative for modelling oral drugs absorption, especially if the optimal number of transit compartments is high and when the LAG, TCM, modified TCM and discrete DDE models exhibit numerical difficulties or poorly depict drug uptake into the blood via extravascular dosing. This research proposes an important

Informative Visualization of Biological Networks in high throughput Systems Biology Investigations

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Abstract. The heterogeneity and high dimensionality of omics data is becoming a severe obstacle for building informative descriptive mathematical models in systems biology that could aid the active global research endeavor toward personalise medicine. A variety of machine learning based mathematical and numerical models have emerged in recent years that summarize the analysis of the huge volume of data generated in research labs around the world and present them is format more amenable to expert interpretation than raw data presented in statistical tables and charts. The results from such models provide a comprehensive summarization of the biological parameters, but for conventional analysis models interpreting the results remain a daunting task even for the domain expert end users (biomedical researchers). In more recent models, biological data are modeled as graphs where nodes correspond to bio-entities (e.g. genes or proteins) and edges represent interaction between them. Biological network analysis methods have been incorporated in a number of proprietary and open-source analysis tools such as GeneNet, and SBEToolbox, and more advanced methods take into account the gene expression values and give increased relevance to the number of differentially expressed genes on known pathways, but unfortunately proteins interaction confidence scores that reflect the reliability/strength of the interaction are ignored. We investigated and developed new topological network analysis tools to extract disease relevant ***biomarkers*** from the large-scale undirected Protein-to-Protein interaction networks. Our tools generate a set of high ranking biomarkers, in the form of a subnetwork of disease relevant pathways, which can be further examined by the domain experts. For a better insights and more informative network analysis, we developed a powerful prototype visualization tool to display the patterns and the structures of the biomarkers complemented with textual description at different layers including topological parameters, documented disease genes. The visualization tool also includes a navigation pane controlled by the user to display the lists of detected biological pathways related to disease.

The Radon transform: tomography and image analysis

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Abstract. The integral transform named after the German mathematician Johann Radon was detailed by him in a 1917 paper. This paper not only describes the transform, but also, famously, derives an inversion formula for it. As will be explained, the x-ray tomography data acquisition process is a direct analogue of the Radon transform, and so tomographic images can be obtained by a data-processing procedure which is effectively an inversion of the transform. Although Radon's inversion formula is not directly applicable by numerical computation, the *de facto* standard tomographic-image reconstruction method, known as filtered back-projection, corresponds to it, as will be shown. The relationship between the Radon and (polar-coordinates) Fourier transforms will also be briefly discussed; this is known as the Fourier-slice theorem. Next, the computational implementation of the Radon transform itself on images will be discussed. It amounts to summations along sets of parallel lines at a substantial number of orientations. Although this is a loss of information in some obvious respects, it probes the image along many angles, and this makes it a dependable approach to certain types of image analysis, such as image classification and feature recognition. The slant-stack algorithm form for implementing the Radon transform will be outlined; it entails Dirichlet-kernel interpolation. Finally, applications of the transform for face recognition and image classification will be discussed.

Robotic Process Automation: An Introduction

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Business Engineering is a form of process and production engineering. The essence is to add value by improving the state of the calculation, data entry, document, spreadsheet or other object at each handling stage. This is a Business Process. Robotic Process Automation (RPA) sets out to automate such processes, to speed the production and free human resources for more difficult and rewarding tasks and projects, or a more leisurely lifestyle. RPA uses scripting macro computer languages based on procedural flowcharting to repeat tirelessly the repetitive tasks which form the bulk of some office job-descriptions. The RPA platform many choose is UIPath which has a Community version. This presentation gives a brief introduction to some of the concepts involved

Breast cancer detection using Topological Analysis of digital Mammograms

Aras Asaad[1], Taban Majeed[2] and Sabah Jassim[1]

ABSTRACT. Mammography are one of the most common and effective techniques used by radiologists for the early detection of the breast cancer. Machine learning is becoming an effective tool for diagnostic purposes using various biomedical imaging systems including digital mammograms. Here, we present a newly emerging topological image analysis approach for the detection of breast cancer from digital mammogram. This approach is based on constructing a sequence of simplicial complexes (SC) whose nodes are certain texture image pixels and iteratively new edges/simplices are added an increasing series of distance thresholds. In this work we deployed different subsets of automatically extracted uniform local binary patterns (ULBP) landmarks as the SC nodes. At each threshold the number of *most frequent degree* (MFD) nodes is shown to be malignancy discriminating topological features to be trained and tested by a multi-threshold machine learning classifier. We shall demonstrate experimentally, using a large database of digital mammogram scan images, that the proposed TDA scheme has a very high performance in breast cancer detection from Mammogram. We present an analysis of the pattern of accuracy across a range of thresholds.

A generalised defect correction method and its applications in option pricing

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Abstract

The Black-Scholes partial differential equation is well known to be an option pricing tool for an ideal market. This requires the use of constant volatility over the period of time from zero up to the mature time. For realistic markets the volatility may become nonlinear, and the partial differential equation becomes nonlinear. A typical example is Frey and Patie nonlinear volatility model which contains a very small parameter in it. In addition to the nonlinearity a correction term may be added to the Black-Scholes partial differential equation to facilitate discrete hedging. The technique of defect correction method is extended to handle this type of nonlinear partial differential equations.

Several examples of the defect correction method are used to motivate the use of defect correction method and the adaptation of it to handle asymptotic expansion and nonlinear correction term is to be discussed. Numerical examples of an European option pricing will be used to demonstrate the algorithm.

The mathematics of Pareto rankings and tournament selection

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Tournament selection with and without replacement is considered within the context of multi-objective evolutionary algorithms (MOEAs). Conclusions are drawn regarding asymptotic behaviour and the suitability of different schemes. As a result, a number of propositions are made that govern the structures of ranks, ranking systems, and the convergence of the MOEAs that use them. Beside the insights into the population structures in MOAs this analysis provides, it also leads to means for tuning selection pressure and other relevant parameters. Some illustrations are provided.

The Plant Propagation Algorithm and the University Course Timetabling Problem

(progress report)

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The Plant Propagation Algorithm (PPA) is a relatively new heuristic algorithm that has shown promising experimental results on both single- and multi-objective continuous optimization problems. The University Course Timetabling Problem (UCTP) in which course activities, teachers and students are scheduled is a notorious optimization problem faced by many universities all over the world. It has been approached by a multitude of heuristical algorithms such as Local Search, Genetic Algorithms, Ant Colony Optimization, and Simulated Annealing. In this study, we use anonymized real data on times, rooms, courses, activities and students from several studies at the University of Amsterdam. We define the objective function together with the staff of the university's timetabling services and adapt the Plant Propagation Algorithm from previous applications such as the Traveling Salesman Problem to address this real-life instance of the UCTP. As the study is still ongoing, we will present intermediate results, and be open to feedback, ideas and suggestions for future directions of the investigation.

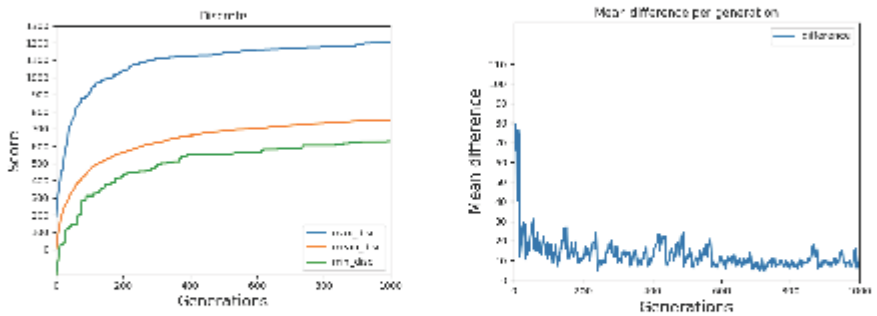

Figure.: (left) The maximum, mean and minimum scores found over 1000 generations for the Plant Propagation Algorithm on UCTP. (right) The mean difference between plants in the population for each from the same 1000 generations.

A Heuristic Decomposition based on Column Generation Approach for Combining Orders in Inland Transportation of Containers

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Abstract:

The inland transportation takes a significant portion of the total cost that arises from intermodal transportation. In addition, there are many parties (shipping lines, haulage companies, customers) who share this operation as well as many restrictions that increase the complexity of this problem and make it NP-hard. Therefore, it is important to create efficient strategies to manage this process in a way to ensure all parties are satisfied.

In this research, we design a Mixed Integer Linear Programming (MILP) model for combining orders in the inland, haulage transportation of containers. In this MILP model, the pick-up and delivery process of both 20 and 40 foot containers from the terminals to the customer locations and vice versa are optimized using heterogeneous fleet consists of both 20ft and 40ft trucks/chassises. Based on an assignment model, this MILP solves problems with 100 orders efficiently to optimality. To deal with larger instances, a decomposition and aggregation heuristic is designed. Based on decomposed solutions, orders that are "fully" combined with others are removed and an aggregation phase follows to enabling wider combination choices across subgroups. The decomposition and aggregation solution process is tested to be both efficient to solve large size of instances and cost-saving.

Plant Propagation as a metaheuristic for an optimal VLSI-router
(progress report)

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The Plant Propagation Algorithm, a promising population-based heuristic for constrained optimization problems, is used as metaheuristic for a router in a simplified VLSI-model. The model consists of a multilayer grid with logical gates placed on intersections in the lowest layer, and a list with gate pairs (a *net list*) to be wired up. The router, an optimal A-star algorithm, is bound by two constraints: firstly, nets must move along the grid's edges in x,y, and z-directions. Second, nets cannot share an edge or intersection on the grid, as it leads to short-circuit malfunction. So the *order* in which the nets are routed by the A-star algorithm is of crucial importance for the quality of the solution, as earlier routed nets might potentially obstruct paths for later routed nets. Any particular order of nets to be routed may therefore result in longer wire length than strictly necessary, or even in nets being unroutable altogether.
In this study, we optimize this order of nets by stochastic hillclimbing, simulated annealing and the Plant Propagation Algorithm from Salhi and Fraga's seminal paper[1]. As the study is still ongoing, we will present first results, and be open to feedback, ideas and suggestions for future directions of the investigation.

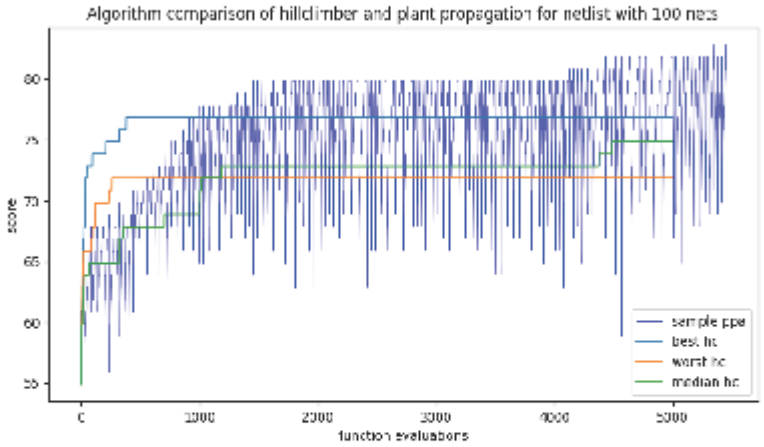

Figure 1 Early results seem to indicate that the Plant Propagation Algorithm produces much better results than stochastic hillclimbing when applied to the order in which nets are fed to and A-star router in simplified VLSI-design.

1. Salhi, A. & Fraga, E. S. Nature-Inspired Optimisation Approaches and the New Plant Propagation Algorithm. (2011)

Solving the Solid Assignment Problem

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Abstract

The Solid Assignment Problem (SAP) also known as the 3-dimensional assignment problem, consists in allocating *n* jobs to *n* machines in *n* factories such that exactly one job is allocated to one machine in one factory. The objective function is to minimise the total cost of the allocation. SAP is an extended version of the standard 2-dimensional assignment problem, which aims to assign *n* tasks to *n* operators at minimum total cost. This combinatorial optimisation problem appears in many applications and has aroused research interests for decades. In this paper, we suggest a new heuristic algorithm called the Diagonal Method (DM) to solve SAP. The largest SAP solved with an exact solution to this day is of size *n*=26. As it is intractable, only approximate solutions are found in reasonable time for larger instances. DM that we suggest here is an approximate solution approach, which relies on the Kuhn-Tucker Munkres algorithm, also known as the Hungarian method. The new approach is discussed, hybridised, presented and compared with the Branch-and-Bound method (B&B). Tie cases are discussed with examples. Our numerical experiments for larger instances show that DM finds optimal or near-optimal solutions in competitive computational times.

Key words: Solid assignment problem, Diagonal method, Branch-and-Bound method and Hungarian method.

A metaheuristic Optimization approach for solving a real-life Gas Delivery Problem

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In this paper we consider a real-life gas delivery vehicle routing problem, characterized by heterogeneous vehicle fleet, demand-dependent service times, maximum allowable overtime and a special light load requirement. A new learning-based Population Variable Neighbourhood metaheuristic Optimization Search algorithm is designed to address this complex logistic problem. The computational experience suggests that savings up to 8% can be achieved when overtime and light load requirements are considered in advance. Moreover, accommodating for allowable overtime has shown to yield 12% better average utilization of the driver's working hours and 12.5% better average utilization of the vehicle load, without incurring extra running costs. The proposed metaheuristic method also shows some competitive results when applied to the special case of the real-life Vehicle Routing Problem, namely the Fleet Size and Mix Vehicle Routing Problem.

Keywords

Population Variable Neighbourhood Search; Adaptive Memory; Real Life Vehicle Routing; MIP Formulation; Metaheuristic

Food Safety Systems for Identifying Critical Limits at Critical Control Points in Food Manufacturing: On Reducing Risk of Contaminant in Food Products

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Abstract

Uncertainties in parameters of critical control points are major sources of contaminants in food products and establishing critical limits at control points to meet food safety and business objectives is a challenge and an important task for food manufacturers and the food industry. This study designed multi-objective deterministic and probabilistic optimisation systems to obtain near-optimal critical limits at critical control points of food processing operations that will help prevent the risk of foodborne illness while keeping manufacturing cost as low as possible. With a hypothetical case study, we demonstrate how the systems can be used to obtain critical limits at process operations units of an integrated food manufacturing system, and their impacts on of key performance indicators - contaminant concentration and manufacturing cost. Reliability analyses were conducted to assess system performance. We define reliability as the likelihood that the system will fail to meet target level of contaminant concentration and obtained its estimate using random parameters of critical control points. Results suggest that target concentration of contaminant, desired level of system reliability, and the number of uncertain parameters of critical control points that are included in design affects both performance indicators. By restricting the fluctuation of uncertain parameters, low processing cost at higher reliability can be achieved. Result also show that contaminant concentration and its deviation are less in the probabilistic designed system. The demonstrated optimisation approach helped in evaluating the trade-off between reliability and economic benefit.

Latin Hypercube Sampling and Regression Trees applied to Process Scale-up under Uncertainty

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Abstract

Sustainability is a great concern in the global energy sector. When looking for reliable and clean energy sources, one of the main solutions found relies on solar technology. Therefore, it is important to reduce the cost of solar modules, which would increase the potential of such a solution. Most solar cells are made of Transparent and Conductive Oxide (TCO) films, which can be manufactured using a process named Aerosol-Assisted Chemical Vapour Deposition (AACVD). In summary, AACVD is comprised of aerosol generation, transport and delivery. Firstly, a solution containing TCO precursors is atomised to generate aerosol. Then, the aerosol is transported to a heated chamber, where the solvent evaporates and the precursors deposit, forming the desired film. In addition to TCOs, the AACVD process can be used to produce composites, powders, coatings and nanotubes.

Surveying the literature, one can find experimental results from small-scale AACVD applications. However, not much can be found on the computational modelling of such a process, which would be useful for scaling-up purposes. Therefore, we present an integrated model comprised of aerosol generation, transport and delivery. Uncertainty and sensitivity analyses are performed throughout the process, based on exploration of the design space using the Latin hypercube sampling method and the use of regression trees to rank the importance of different variables. For the aerosol generation, we can predict the range of droplet sizes obtained when ultrasonically atomising the precursor solution. The results are based on probability distributions, which are also used as part of the inputs for the transport model. Other inputs include the properties of the droplets, the flow and the piping system. We can then predict the fraction of aerosol that reaches the heated chamber and its size distribution. Finally, in the heated chamber, the solvent evaporation is modelled, which depends mainly on the temperature profile of the site and the flow conditions. The precursors are now free to deposit and form the desired products.

Probability theory was used to incorporate the stochastic aspects of aerosol generation, transport and delivery. Experimental results were used to validate the model predictions for aerosol sizing and loss. Through the formulation of an optimisation problem, the model presented has been used to suggest possible designs for the transport system, minimising the loss of aerosol. This approach is suitable for transport distances on the scale of industrial processes. The models presented here can also be used for other applications based on particle atomisation and transport, such as fuel combustion and spray drying or cooling. Finally, the knowledge acquired while handling uncertainties in the modelling of the AACVD process has been used to plan a modelling framework that will enable us to represent uncertainties and manipulate variables with uncertain values for process modelling in general.

Strawberries and Fireworks

(progress report)

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From the looks of it, the Fireworks Algorithm (FWA) and the Plant Propagation Algorithm (PPA) share a lot of algorithmic similarities and experimental results. Both are population-based algorithms that select individuals to generate offspring. In both algorithms, a fitter individual creates many offspring with small mutations and conversely, an unfitter individual creates fewer offspring with relatively large mutations. As the heuristical (d)evil is usually in the details, a more rigourous study is needed to either confirm or disconfirm these similarities. This investigation compares the operational details and numerical results on a set of well-known benchmark functions for these two algorithms. We will present preliminary results, and be open to feedback, ideas and suggestions for future directions.

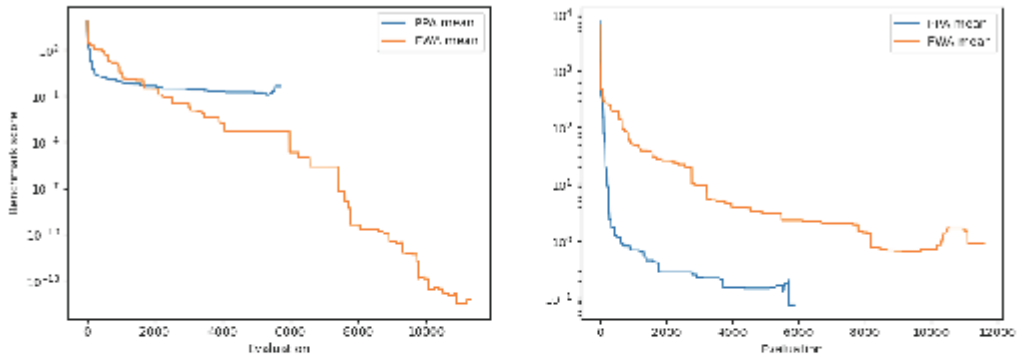

Fig.: (left) Preliminary results show that both algorithms yield reasonably good results on the standard two-dimensional 'Sphere' benchmark function when ran for 100 generations with default parameters. However, as soon as the global minimum is shifted away from the origin (right), PPA appears to substantially outperform FWA on the same benchmark function. Results are 10-run means, and normalized along function evaluations because of differences in population size and offspring numbers.

On the stochastic modelling of surface reactions through reflected chemical Langevin equations

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Abstract

Modelling of small-scale heterogeneous catalytic systems with master equations captures the impact of molecular noise, but can be computationally expensive. On the other hand, the chemical Fokker-Planck approximation offers an excellent alternative from an efficiency perspective. The Langevin equation can generate stochastic realisations of the Fokker-Planck equation; yet, these realisations may violate the conditions of bounded surface coverage. In this work, we adopt Skorokhod's formulations to impose reflective boundaries that remedy this issue. We demonstrate the approach on a simple system involving a single species and describing adsorption, desorption, reaction and diffusion processes on a lattice. We compare different numerical schemes for the solution of the resulting reflected Langevin equation and calculate rates of convergence. Our benchmarks should guide the choice of appropriate numerical methods for the accurate and efficient simulation of chemical systems in the catalysis field.

The support for this work provided by the Leverhulme Trust (project RPG-2014-161) is gratefully acknowledged.

Analysis of discrete systems via variational method

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ABSTRACT

We discuss a variational method in analysis of discrete systems and looked at some related examples. We will then employ two types of trial functions (Gaussian and exponential) to approximate the solutions and analyse their stability from a dynamical system perspective. In particular, we will focus on discrete soliton solutions of the discrete nonlinear Schrödinger equations (DNLS).

Homoclinic snaking of discrete solitons with saturable optical cavities

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I will present the study of time-independent solutions of an optical cavities equation with saturable nonlinearity. This equation admits uniform and localized solutions. The localised solutions can be formed by combining two states of uniform solutions which can develop a snaking structure in their bifurcation diagrams. By varying the coupling strength and linear coefficient parameters, one will obtain a snaking regime called the pinning region. $\Subset$-shaped isolas may also be obtained. I will also introduce a one-site approximation to analyse the localized solution and their stability (semi)analytically. Comparisons with numerical simulations show that the one-active site approximation gives good agreement.

Keywords : optical cavities, localized state, homoclinic snaking, $\Subset$-shaped isolas.

Emergence of Topological Data Analysis in Machine Learning

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Abstract. Topological Data Analysis (TDA) has emerged recently to provide a natural framework for representing and machine learning Bigdata records that in increasing number of applications cluster and form distinctive shapes resembling simplicial complexes. TDA is based on analyzing such data shapes in terms of certain topological invariants at different resolution with emphasis on the persistent properties of the computed topological structures. Naturally, Artificial Intelligence (AI) is the hope for analyzing Bigdata, and due to enormity of the tasks Deep learning (DL) has emerged in recent years as the only realistic approach. Beside efficiency shortcoming, DL does not easily provide adequate informative interpretation of its decisions. We shall present ample evidences that the role of TDA can be extended far beyond obvious Bigdata applications. and demonstrate that indeed TDA can provide an informative more efficient advanced multi-level machine learning alternative to Deep Learning. TDA amenable applications include classification of high dimensional records where relatively small set of landmark features spread over the records (perhaps in transformed domains) exhibit some discriminative properties. In such cases, repeatedly classifying the data records at a sequence of distance/similarity thresholds by the patterns of topological parameters of the simplicial complexes formed by the landmarks at each threshold, provide multi-level machine learning process that encapsulate both global and local decision supporting evidences. We shall demonstrate our conclusions by reviewing the various pioneering research conducted for image analysis applications that TDA provided a very effective tool for image quality assessment, medical diagnoses using radiology scan images, image steganalysis, and for detecting serious intentional tampering as well as un-intentional degradation.

Demand Response Management and Real Time Pricing Issues in Smart Grids

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Abstract

This presentation is related to discussion about the demand response management and real time pricing in Smart Grid. Firstly, I give a brief introduction to Smart Grid and the issues related to that area. Then I explain a little about the technology of Advanced Metering Infrastructure (AMI) and then I will have brief explanation about energy management unit. Then I explain about the optimization problem that is considered for satisfaction of both sides of end users and distribution companies and finally I review briefly my proposed algorithm. There are some future research suggestions that will come at the end if time allows.

Modelling of Hydropower Generator Characteristic Impedance

S. A. S. Alarefi and S. Walker, 'Investigations and Modelling of Hydroelectric Power Generators Characteristics Impedance,' *19th International Conference on Industrial Technology ICIT*, Lyon, IEEE, 2018.

A novel heuristic model for hydroelectric power generation is derived from pioneer empirical investigations into the electrical characteristics of micro-hydro power generators MHPG. The results introduce a new understanding of MHPG properties. Arguably, the most useful is the observation of constant ohmic source impedance in these generators (i.e. linear power system). A second major finding concerns the variable multi-flow correlation between the voltage and current at the maximum power point, which coincides with 50% V_{oc} and 50% I_{sc} (i.e. 50 % of the MHPG maximum available voltage and current). The MALTAB-Simulink simulation carried out in validating the proposed heuristic model, concurred satisfactorily well with the experimental observations. These novel heuristic MHPG models are expected to assist with emerging hydropower generation strategies.

Hybridising Strip Algorithms and the 2-Opt Rule for Graph-based Optimisation Problems

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Abstract:

The Strip Algorithm (SA) is a constructive heuristic, which has been tried on the Euclidean Travelling Salesman Problem (ETSP) and other planar network problems with some success. Its attraction is its efficiency.

In [1], the Classical Strip Algorithm (CSA) was revisited and new variations of it were introduced.

In this talk, we suggest how to improve the performance of some variants of the SA by combining them with the 2-opt rule and deploy them as cheap yet efficient local search methods for hard optimisation problems such as TSP.

[1] Selamoglu B.I., Salhi A., Sulaiman M. (2018) Strip Algorithms as an Efficient Way to Initialise Population-based Metaheuristics. In: Amodeo L., Talbi EG., Yalaoui F. (eds) Recent Developments in Metaheuristics. Operations Research/Computer Science Interfaces Series, Vol 62. Springer.

Don't walk back in anger

Vanni Noferini

In network theory, a system of interacting actors (for example, a social network and its users, with the interaction of being friends/followers/etc.) is modelled by a graph. It is of interest to define and compute a ranking of the nodes, called a centrality measure, representing the relative importance of the actors. Several efficient techniques based on matrix theory are available to compute centrality measures based on the combinatorics of walks on the graph. However, depending on the underlying model, not all walks are equally good. I will discuss some very recently introduced centrality measure that only counts nonbacktracking walks, i.e., walks that do not include subsequence of nodes of the form ...iji... I will illustrate the motivation to do this, the mathematical theory developed to study these walks, and finally the techniques to compute the corresponding centrality.

This is based on various papers coauthored with (different subsets of) Francesca Arrigo (Strathclyde), Des Higham (Strathclyde), and Peter Grindrod (Oxford).

An Approximate Dynamic Programming Approach to Attended Home Delivery Management

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In attended home delivery, the firm sends out delivery vans to visit customer locations within pre-booked time slots to drop orders. In this study we investigate how to manage the delivery price dynamically to steer customers' choices of time slots to enhance the e-grocer's profit. The opportunity cost of accepting an order of a certain volume and location into a specific time slot consists of two parts: the expected displacement cost of future orders due to committing to this order, and the marginal delivery cost.

The second part relies on the solution of a capacitated vehicle routing problem with time windows which is NP-hard. To provide an instant online estimation of the additional delivery cost, we propose a geographical decomposition of the service area based on a continuous routing distance approximation strategy, and use approximate dynamic programming with linear regression to estimate the opportunity cost. A large-scale empirical study of our pricing policy using a major e-grocer's data set indicates profit improvements of over 2% compared to a fixed-price benchmark policy across all considered demand scenarios.

Justification of the rotating wave approximation in damped, driven weakly coupled oscillators

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We consider a discrete nonlinear Klein-Gordon equation with damping and external drive terms. Using small amplitude ansatz, one can approximate it by a damped, driven discrete nonlinear Schrödinger type equation. Here, we prove the local and global existence of the discrete Schrödinger equation. Furthermore, we show the justification of this approximation by finding the error bound using energy estimate. Numerical comparisons of discrete breathers obtained from the original nonlinear equation and the discrete nonlinear Schrödinger equation are presented describing the analytical results.