UKCI2014
8-10 September 2014
University of Bradford

General Chair: Professor Daniel Neagu
2014 14th UK Workshop on Computational Intelligence (UKCI)

University of Bradford
Student Central Lecture Theatre SC0.51
Bradford, West Yorkshire, UK
8-10 September 2014

Editors
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UKCI2014 Programme of Events

Monday 8th September 2014

0800 – 1200 Registration (Student Central Boardroom SC0.56)

0900 – 0930 Welcome Talk (Student Central Lecture Theatre SC0.51)
Professor Brian Cantor CBE, Vice-Chancellor and Principal of the University of Bradford

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Professor Peter Cowling, University of York

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Session Chair: Dr Paul Trundle, University of Bradford
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A novel approach for ANFIS modelling based on Grey system theory for thermal error compensation
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Session Chair: Dr Mariam Kiran, University of Bradford

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Session Chair: Dr Kenneth McGarry, University of Sunderland

Adaptive Learning with Covariate Shift-Detection for Non-Stationary Environments  
Haider Raza, Girijesh Prasad and Yuhua Li

Search-guided Activity Signals Extraction in Application Service Management Control  
Tomasz D. Sikora and George D. Magoulas

Modeling Neural Plasticity in Echo State Networks for Time Series Prediction  
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Mark Barrett, Open Data Lead for Leeds

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Session Chair: Dr Longzhi Yang, Northumbria University

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Fast Learning method of Interval Type-2 Fuzzy Neural Networks
Damian Olczyk and Urszula Markowska-Kaczmar

Refinement of Fuzzy Rule Weights with Particle Swarm Optimisation
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A Benchmark Generator for Dynamic Multi-objective Optimization Problems
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PCA-based Algorithmic Approximation of Crisp Target Sets
Ray-Ming Chen

Optimized Artificial Neural Network Using Differential Evolution for Prediction of RF Power in VHF/UHF TV and GSM 900 Bands for Cognitive Radio Networks
Sunday Iliya, Eric Goodyer, Mario Gongora, John Gow and Jethro Shell

Truss Topology Optimization with Species Conserving Genetic Algorithm
Jian-Ping Li and Felician Campean

The Effect of Attribute Pairings in Intrusion Detection
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Towards Automated Monitoring of Adult Zebrafish
Qussay Al-Jubouri, Waleed Al-Nuaimy, Hamza S. AlZu'bi, Osama Zahran and Jonathan Buckley

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UKCI2015: Professor Richard Everson General Chair, University of Exeter

1830: UKCI2014 Dinner. Best Student Paper Award presentation (Midland Hotel)
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Session Chair: Professor Rami Qahwaji, University of Bradford

An Efficient System For Preprocessing Confocal Corneal Images For Subsequent Analysis
Mhd Saeed Sharif, Rami Qahwaji, Sofyan Hayajneh, Stan Ipson, Rania Alzubaidi and Arun Brahma

Human Activity Classification Using A Single Accelerometer
Hamzah S. AlZubi, Simon Gerrard-Longworth, Waleed Al-Nuaimy, Yannis Goulermas and Stephen Preece

Multiple sensor outputs and computational intelligence towards estimating state and speed for control of lower limb prostheses
Pamela A. Hardaker, Benjamin N. Passow and David Elizondo

1000 – 1020 Tea and Coffee Break

1020 - 1140 Session 7: Intelligent Technologies for Healthcare and Behaviour Analysis 2
Session Chair: Dr Waleed Al-Nuaimy, University of Liverpool

Blood-Glucose Pattern Mining Algorithm for Decision Support in Diabetes Management
Majid A. Al-Taee, Suhail N. Abood, Waleed Al-Nuaimy and Ahmad M. Al-Taee

Integrated Microarray Analytics for the Discovery of Gene Signatures for Triple-Negative Breast Cancer
Masood U.H. Zaka, Yonghong Peng and Chris W. Sutton

Prediction of Driver Fatigue: Approaches and Open Challenges
Hilal Abood, Waleed Al-Nuaimy, Ali Al-Ataby, Sameh A. Salem and Hamzah S. AlZubi

Using Computational Methods for the Prediction of Drug Vehicles
Pritesh Mistry, Anna Palczewska, Daniel Neagu and Paul Trundle

1140 – 1230 Lunch Break

1230 – 1330 Invited Keynote Talk
Learning about Activities and Objects from Video
Professor Anthony Cohn, University of Leeds
**Keynote Talks**

*Computational Intelligence Research for Impact in the Games Industry:*
*Professor Peter Cowling, University of York*

**Abstract:** Digital Games are a huge international industry, with revenues of £3 billion in the UK and over $70 billion worldwide, far exceeding that of film, music and DVD. Games have been an important testbed for AI/CI research for decades, since pioneering work by Turing and Shannon. Computational Intelligence is an important component of many (arguably most) commercial digital games. Games provide a superb testbed for CI research, and one whose potential we are only just starting to understand. In this talk we will present significant research advances our team has made in Monte Carlo Tree Search, and discuss how these were used by a commercial games company (AI Factory Ltd.) resulting in our research advances being used by 2.5 million game players worldwide in a chart-topping mobile phone game. We will describe how our Monte Carlo Tree Search approaches, tailored for "strong" gameplay, needed to be recast to yield "fun" gameplay as needed by the commercial market. Furthermore, widespread play against our CI produced a deluge of data. Subsequently, we analysed this data to understand how human players react to different CI playing styles - providing new metrics for our CI which would not have been possible without massive amounts of gameplay data from human players. We will round out the talk by discussing other examples where digital games have been used to do science, and by speculating as to the future of games as a tool for research in CI and other fields.

**Biography:** Peter Cowling wrote his first game playing Artificial/Computational Intelligence (AI), for the board game Othello, at about 9 years of age, on a Commodore PET computer with a mighty 8 kilobytes of RAM (about one tenth of one percent of the size of a single decent digital photograph nowadays :). He was quickly hooked and has created many games and AI for games as a way to test out research ideas in AI during his research career [1], as well as inventing hyperheuristics [2] and extensive work in Operational Research (see e.g. [3]) with organisations such as AI Systems BV, Gaist Solutions Ltd, Trimble MRM and the Nationwide Building Society. Now, with the rise and rise of the games industry, games is an economically and socially important area of research and is a principal area of his work. He currently leads the EPSRC Centre for Doctoral Training in Intelligent Games and Game Intelligence (IGGI - [www.iggi.org.uk](http://www.iggi.org.uk)) and the EPSRC/ESRC New Economic Models and Opportunities for Digital Games (NEMOG) projects ([www.nemog.org](http://www.nemog.org)), as well as collaborative projects in optimisation and decision-making.

**Deriving the most value out of local data:**

*Mark Barrett, Open Data Lead for Leeds*

**Abstract:** Data.gov.uk is the central repository for Open Data in the UK and holds nearly 20,000 datasets. Of these 20,000 only 3% come from local councils and are classified as "Open". With such a disparity between nationally available data and locally available data, there is a lot of work needed to close the gap. Significant amounts of data are held behind closed doors, but could be made "Open". This provides opportunities for cities to release data, from across sectors, so that citizens can understand their cities in new exciting ways. Over the last 9 months we have worked to release increasing amounts of data, engage with citizens and create a new economy in the city. This talk will give highlight the work that's been carried out.

**Biography:** Mark Barrett is an Open Data Lead for Leeds. He created Leeds Data Mill - the Open Data platform for the city that holds public sector, private sector, and third sector data so create a rich picture of Leeds. Mark co-founded Leeds Data Thing, and created the 1st Open Data app to reach #1 in iTunes - GP Ratings and was selected as one of the top 50 innovators in healthcare by the Health Service Journal in 2013. Marks passion is for local level data - helping people to understand their environment and improve their surroundings.

**Learning about Activities and Objects from Video:**

*Professor Anthony Cohn, University of Leeds*

**Abstract:** In this talk I will present ongoing work at Leeds on building models of video activity. I will present techniques, both supervised and unsupervised, for learning the spatio-temporal structure of tasks and events from video or other sensor data, particularly in the case of scenarios with concurrent activities. In both cases, the representation will exploit qualitative spatio-temporal relations. A novel method for robustly transforming video data to qualitative relations will be presented. I will also show how objects can be "functionally categorised" according to their spatio-temporal behaviour.

**Biography:** Tony Cohn holds a Personal Chair at the University of Leeds, where he is Professor of Automated Reasoning. He is presently Director of the Institute for Artificial Intelligence and Biological Systems. His work on Knowledge Representation and Reasoning has a particular focus on qualitative spatial/spatio-temporal reasoning, the best known being the well cited Region Connection Calculus (RCC). His current research interests range from theoretical work on spatial calculi and spatial ontologies, to cognitive vision, modelling spatial information in the hippocampus, and detecting buried underground assets (e.g. utilities and archaeological residues) using a variety of geo-located sensors. He has been Chairman/President of SSAISB, ECAI, KR inc, the IJCAI Board of Trustees and is presently Editor-in-Chief of the AAAI Press, Spatial Cognition and Computation, and the Artificial Intelligence journal. He was elected a founding Fellow of ECAI, and is also a Fellow of AAAI, AISB, the BCS, and the IET. Work from the Cogvis project won the British Computer Society Machine Intelligence prize in 2004, and the VAULT system from his Mapping the Underworld project won a 2012 IET Innovation Award.
Papers

Session 1: Emerging and Applied Computational Intelligence

Pathfinding in partially explored games environments. The application of the A* Algorithm with Occupancy Grids in Unity3D
John Stamford, Arjab Singh Khuman, Jenny Carter & Samad Ahmadi
Centre for Computational Intelligence
School of Computing
De Montfort University
Leicester, United Kingdom

Abstract—One of the key aspects of games development is making Non-Playable Characters (NPC) behave more realistically in the environment. One of the main challenges is creating an NPC that is aware of its surroundings and acts accordingly. The A* Algorithm is widely used in the games development community to allow AI based characters to move around the environment however unlike real characters they are often given information about the environment without having to explore. This paper combines the use of the A* Algorithm with the occupancy grid technique to allow Non-Playable Characters to build their own representation of the environment and plan paths based on this information. The paper demonstrates the application of the approach and shows a range of testing and its limitations.

Evolution-In-Materio: Solving Function Optimization Problems Using Materials
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Abstract—Evolution-in-materio (EIM) is a method that uses artificial evolution to exploit properties of materials to solve computational problems without requiring a detailed understanding of such properties. In this paper, we show that using a purpose-built hardware platform called Mecobo, it is possible to evolve voltages and signals applied to physical materials to solve computational problems. We demonstrate for the first time that this methodology can be applied to function optimization. We evaluate the approach on 23 function optimization benchmarks and in some cases results come very close to the global optimum or even surpass those provided by a well-known software-based evolutionary approach. This indicates that EIM has promise and further investigations would be fruitful.

Integration Strategies for Toxicity Data from an Empirical Perspective
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Abstract—The recent development of information techniques, especially the state-of-the-art “big data” solutions, enables the extracting, gathering, and processing large amount of toxicity information from multiple sources. Facilitated by this technology advance, a
framework named integrated testing strategies (ITS) has been proposed in the predictive toxicology domain, in an effort to intelligently jointly use multiple heterogeneous toxicity data records (through data fusion, grouping, interpolation/extrapolation etc.) for toxicity assessment. This will ultimately contribute to accelerating the development cycle of chemical products, reducing animal use, and decreasing development costs. Most of the current study in ITS is based on a group of consensus processes, termed weight of evidence (WoE), which quantitatively integrate all the relevant data instances towards the same endpoint into an integrated decision supported by data quality. Several WoE implementations for the particular case of toxicity data fusion have been presented in the literature, which are collectively studied in this paper. Noting that these uncertainty handling methodologies are usually not simply developed from conventional probability theory due to the unavailability of big datasets, this paper first investigates the mathematical foundations of these approaches. Then, the investigated data integration models are applied to a representative case in the predictive toxicology domain, with the experimental results compared and analysed.

Nonlinear control of the underactuated hovercraft using the Derivative-free nonlinear Kalman Filter

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Abstract—The paper proposes a nonlinear control approach for the underactuated hovercraft model based on differential flatness theory and using a new nonlinear state vector and disturbances estimation method under the name of Derivative-free nonlinear Kalman Filter. It is proven that the sixth order nonlinear model of the hovercraft is a differentially flat one. It is shown that this model cannot be subjected to static feedback linearization, however it admits dynamic feedback linearization which means that the system’s state vector is extended by including as additional state variables the control inputs and their derivatives. Next, using the differential flatness properties it is also proven that this model can be subjected to input-output linearization and can be transformed to an equivalent canonical (Brunovsky) form. Based on this latter description the design of a state feedback controller is carried out enabling accurate maneuvering and trajectory tracking. Additional problems that are solved in the design of this feedback control scheme are the estimation of the nonmeasurable state variables in the hovercraft’s model and the compensation of modeling uncertainties and external perturbations affecting vessel. To this end, the application of the Derivative-free nonlinear Kalman Filter is proposed. This nonlinear filter consists of the Kalman Filter’s recursion on the linearized equivalent of the vessel and of an inverse nonlinear transformation based on the differential flatness features of the system which enables to compute state estimates for the state variables of the initial nonlinear model. The redesign of the filter as a disturbance observer makes possible the estimation and compensation of additive perturbation terms affecting the hovercraft’s model. The efficiency of the proposed nonlinear control and state estimation scheme is confirmed through simulation experiments.

A novel approach for ANFIS modelling based on Grey system theory for thermal error compensation

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Abstract—The fast and accurate modelling of thermal errors in machining is an important aspect for the implementation of thermal error compensation. This paper presents a novel modelling approach for thermal error compensation on CNC machine tools. The method combines the Adaptive Neuro Fuzzy Inference System (ANFIS) and Grey system theory to predict thermal errors in machining. Instead of following a traditional approach, which utilises original data patterns to construct the ANFIS model, this paper proposes to exploit Accumulation Generation Operation (AGO) to simplify the modelling procedures. AGO, a basis of the Grey system theory, is used to uncover a development tendency so that the features and laws of integration hidden in the chaotic raw data can be sufficiently revealed. AGO properties make it easier for the proposed model to design and predict. According to the simulation results, the proposed model demonstrates stronger prediction power than standard ANFIS model only with minimum number of training samples.

Session 2: Advances and Applications in Data Mining

Integrate Classifier Diversity Evaluation to Feature Selection Based Classifier Ensemble Reduction
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Abstract—Classifier ensembles improve the performance of single classifier system. However, a classifier ensemble with too many classifiers may occupy a large number of computational time. This paper proposes a new ensemble subset evaluation method that integrates classifier diversity measures into a classifier ensemble reduction framework. The approach is implemented by using three conventional diversity algorithms and one new developed diversity measure method to calculate the diversity’s merits within the classifier ensemble reduction framework. The subset evaluation method is demonstrated by the experimental data: the method not only can meet the requirements of high accuracy rate and fewer size, but also its running time is greatly shortened. When the accuracy requirements are not very strict, but the running time requirements is more stringent, the proposed method is a good choice.

Data Density Based Clustering
Richard Hyde, Plamen Angelov
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Abstract—A new, data density based approach to clustering is presented which automatically determines the number of clusters. By using RDE for each data sample the number of calculations is significantly reduced in offline mode and, further, the method is suitable for online use. The clusters allow a different diameter per feature/dimension creating hyper-ellipsoid clusters which are axis-orthogonal. This results in a greater differentiation between clusters where the clusters are highly asymmetrical. We illustrate this with 3 standard data sets, 1 artificial dataset and a large real dataset to demonstrate comparable results to Subtractive, Hierarchical, K-Means, ELM and DBScan clustering techniques. Unlike subtractive clustering we do not iteratively calculate $P$ however. Unlike hierarchical we do not need $O(N^2)$ distances to be calculated and a cut-off threshold to be defined. Unlike k-means we do not need to predefine the number of clusters. Using the RDE equations to calculate the densities the algorithm is efficient, and requires no iteration to approach the optimal result. We compare the proposed algorithm to k-
means, subtractive, hierarchical, ELM and DBScan clustering with respect to several criteria. The results demonstrate the validity of the proposed approach.

Social Media Analysis for Product Safety using Text Mining and Sentiment Analysis
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Abstract—The growing incidents of counterfeiting and associated economic and health consequences necessitate the development of active surveillance systems capable of producing timely and reliable information for all stakeholders in the anticounterfeiting fight. User generated content from social media platforms can provide early clues about product allergies, adverse events and product counterfeiting. This paper reports a work in progress with contributions including: the development of a framework for gathering and analyzing the views and experiences of users of drug and cosmetic products using machine learning, text mining and sentiment analysis; the application of the proposed framework on Facebook comments and data from Twitter for brand analysis, and the description of how to develop a product safety lexicon and training data for modeling a machine learning classifier for drug and cosmetic product sentiment prediction. The initial brand and product comparison results signify the usefulness of text mining and sentiment analysis on social media data while the use of machine learning classifier for predicting the sentiment orientation provides a useful tool for users, product manufacturers, regulatory and enforcement agencies to monitor brand or product sentiment trends in order to act in the event of sudden or significant rise in negative sentiment.

Kernel Learning Method for Distance-Based Classification of Categorical Data
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Abstract—Kernel-based methods have become popular in machine learning; however, they are typically designed for numeric data. These methods are established in vector spaces, which are undefined for categorical data. In this paper, we propose a new kind of kernel trick, showing that mapping of categorical samples into kernel spaces can be alternatively described as assigning a kernel-based weight to each categorical attribute of the input space, so that common distance measures can be employed. A data-driven approach is then proposed to kernel bandwidth selection by optimizing feature weights. We also make use of the kernel-based distance measure to effectively extend nearestneighbor classification to classify categorical data. Experimental results on real-world data sets show the outstanding performance of this approach compared to that obtained in the original input space.

A New Weighting Scheme and Discriminative Approach for Information Retrieval in Static and Dynamic Document Collections
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Computer Science Dept., Minia University, Egypt
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Abstract—This paper introduces a new weighting scheme in information retrieval. It also proposes using the document centroid as a threshold for normalizing documents in a document collection. Document centroid normalization helps to achieve more effective information retrieval as it enables good discrimination between documents. In the context of a machine learning application, namely unsupervised document indexing and retrieval, we compared the effectiveness of the proposed weighting scheme to the ‘Term Frequency – Inverse Document Frequency’ or TF-IDF, which is commonly used and considered as one of the best existing weighting schemes. The paper shows how the document centroid is used to remove less significant weights from documents and how this helps to achieve better retrieval effectiveness. Most of the existing weighting schemes in information retrieval research assume that the whole document collection is static. The results presented in this paper show that the proposed weighting scheme can produce higher retrieval effectiveness compared with the TF-IDF weighting scheme, in both static and dynamic document collections. The results also show the variation in information retrieval effectiveness that is achieved for static and dynamic document collections by using a specific weighting scheme. This type of comparison has not been presented in the literature before.

Session 3: Advances and Applications in Signal and Image Processing

Adaptive Learning with Covariate Shift-Detection for Non-Stationary Environments  
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Abstract—Learning with dataset shift is a major challenge in non-stationary environments wherein the input data distribution may shift over time. Detecting the dataset shift point in the time-series data, where the distribution of time-series shifts its properties, is of utmost interest. Dataset shift exists in a broad range of real-world systems. In such systems, there is a need for continuous monitoring of the process behavior and tracking the state of the shift so as to decide about initiating adaptation in a timely manner. This paper presents an adaptive learning algorithm with dataset shift-detection using an exponential weighted moving average (EWMA) model based test in a non-stationary environment. The proposed method initiates the adaptation by reconfiguring the knowledge-base of the classifier. This algorithm is suitable for real-time learning in non-stationary environments. Its performance is evaluated through experiments using synthetic datasets. Results show that it reacts well to different covariate shifts.

Search-guided Activity Signals Extraction in Application Service Management Control  
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Abstract—The increased interest in autonomous control in Application Service Management-ASM environments has driven the demand for analysis of multivariate datasets in this area. Gathered metrics form time-series that can be considered as signals, which should be decomposed in order to find relations between system utilization and effective activity. This paper introduces a metrics signal deconvolution method that can be used to support human administrators or can be incorporated into feature extraction schemes that feed decision blocks of autonomous controllers. The method considers ASM
environments signals decomposition as a search problem that is solved using heuristics and metaheuristic strategies. Quantitative and qualitative relations between activity and system resources signals are searched with use of a model that is based on similarity and variability of the changes, under minimal assumptions about the ASM system architecture and design. Experimental results show that the model can be successfully integrated with optimization techniques and the results produced when tested using data produced through queue modeling meet human perception of the signal unmixing problem.

**Modeling Neural Plasticity in Echo State Networks for Time Series Prediction**  
*Mohd-Hanif Yusoff and Yaochu Jin*

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Abstract—In this paper, we investigate the influence of neural plasticity on the learning performance of echo state networks (ESNs) and supervised learning algorithms in training readout connections for two time series prediction problems including the sunspot time series and the Mackey Glass chaotic system. We implement two different plasticity rules that are expected to improve the prediction performance, namely, anti-Oja learning rule and the Bienenstock-Cooper-Munro (BCM) learning rule combined with both offline and online learning of the read-out connections. Our experimental results have demonstrated that the neural plasticity can more significantly enhance the learning in offline learning than in online learning.

**Neural Networks and Wavelet Transform in Waveform Approximation**  
*Paul Farago, Gabriel Oltean, Laura-Nicoleta Ivanciu*

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Abstract—To fully analyze the time response of a complex system, in order to discover its critical operation points, the output waveform (under all conceivable conditions) needs to be generated. Using conventional methods as physical experiments or detailed simulations can be prohibitive from the resources point of view (time, equipment). The challenge is to generate the waveform by its numerous time samples as a function of different operating conditions described by a set of parameters. In this paper, we propose a fast to evaluate, but also accurate model that approximates the waveforms, as a reliable substitute for complex physical experiments or overwhelming system simulations. Our proposed model consists of two stages. In the first stage, a previously trained artificial neural network produces some coefficients standing for “primary” coefficients of a wavelet transform. In the second stage, an inverse wavelet transform generates all the time samples of the expected waveform, using a fusion between the “primary” coefficients and some “secondary” coefficients previously extracted from the nominal waveform in the family. The test results for a number of 100 different combinations of three waveform parameters show that our model is a reliable one, featuring high accuracy and generalization capabilities, as well as high computation speed.

**Investigating the relationship between the distribution of local semantic concepts and local keypoints for image annotation**  
*Yousef Alqasrawi*

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*Daniel Neagu*

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Abstract—The problem of image annotation has gained increasing attention from many researchers in computer vision. Few works have addressed the use of bag of visual words for scene annotation at region level. The aim of this paper is to study the relationship
between the distribution of local semantic concepts and local keypoints located in image regions labelled with these semantic concepts. Based on this study, we investigate whether bag of visual words model can be used to efficiently represent the content of natural scene image regions, so images can be annotated with local semantic concepts. Also, this paper presents local from global approach which study the influence of using visual vocabularies generated from general scene categories to build bag of visual words at region level. Extensive experiments are conducted over a natural scene dataset with six categories. The reported results have shown the plausibility of using the BOW model to represent the semantic information of image regions.

**Session 4: Fuzzy Sets and Fuzzy Systems**

**A Fuzzy Image Congealing-based Handwritten Chinese Character Recognition and Classification System**

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Abstract—The recognition and classification of handwritten Chinese characters poses a significant challenge for automated methods. Indeed the sheer number of characters, intricate complexity of such characters, and variations in writing styles mean that the task can be difficult even for humans. Previous work in this area has focused upon methods which perform a certain form of feature extraction and segmentation as the basis for building systems to perform this task. This paper proposes two approaches for handwritten Chinese character recognition and classification using an image alignment technique based on a fuzzy-entropy metric. Rather than extracting features from the image, which can often result in subjective and poorly-fitting models, the proposed methods instead uses the mean image transformations of the training phase as a basis for building models. The use of a fuzzy-entropy based metric also means improved ability to model different types of uncertainty. The mean image transformations are then collated, and used as training data to classify the images of test characters. A nearest-neighbour classifier based on Euclidean distance is then used to classify each test character. The approaches are applied to a publicly available real-world database of handwritten Chinese characters and demonstrate that they can achieve high classification accuracy.

**Fuzzy Adaptive Parameter Control of a Late Acceptance Hyper-heuristic**

Warren G. Jackson, Ender Ozcan and Robert I. John

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Abstract—A traditional iterative selection hyper-heuristic which manages a set of low level heuristics relies on two core components, a method for selecting a heuristic to apply at a given point, and a method to decide whether or not to accept the result of the heuristic application. In this paper, we present an initial study of a fuzzy system to control the list-size parameter of late acceptance move acceptance method as a selection hyper-heuristic component. The performance of the fuzzy controlled selection hyper-heuristic is compared to its fixed parameter version and the best hyper-heuristic from a competition on the MAX-SAT problem domain. The results illustrate that a fuzzy control system can potentially be effective within a hyper-heuristic improving its performance.

**Interval Type-2 Fuzzy Sets in Supplier Selection**

Seda Türk, Robert John and Ender Özcan
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Abstract—Selection of an appropriate supplier is a crucial and challenging task in the effective management of a supply chain. This study introduces a model for solving the supplier selection problem using interval type-2 fuzzy sets. Moreover, the influence of the membership function shape on the results obtained from the model has been investigated on a real-world problem instance tackled by Ordoobadi.

Fast Learning method of Interval Type-2 Fuzzy Neural Networks
Damian Olczyk and Urszula Markowska-Kaczmar
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Abstract—The Fuzzy Set Parameter Estimation algorithm is proposed for fast learning interval type-2 fuzzy neural networks applied for classification problems. Classes are disjoint. Learning consists of estimating appropriate values of fuzzy set parameters in every rule. Estimation is based on statistical properties of the training data. The experimental study confirms that it is dozens times quicker than the backpropagation method, while the classification effectiveness is comparable.

Refinement of Fuzzy Rule Weights with Particle Swarm Optimisation
Tianhua Chen, Qiang Shen, Pan Su and Changjing Shang.
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Abstract—The most challenging problem in the design of fuzzy rule-based classification systems is the construction of a fuzzy rule base for the target problem. Much research has focused on generating and adjusting antecedent fuzzy sets. In many cases, initial fuzzy sets, each of which has a linguistic meaning, are predefined by domain experts and are thus required to be maintained in order to ensure interpretability of any subsequent inference results. However, learning fuzzy rules using fixed fuzzy quantity space without any quantification will restrict the accuracy of the resulting rules. Fortunately, adjusting the weight of a fuzzy if-then rule may help improve classification accuracy without degrading the interpretability. There have been different proposals for fuzzy rule weight tuning through the use of various heuristics with limited success. This paper proposes an alternative approach using Particle Swarm Optimisation in the search of a set of optimal rule weights, which can entail high classification accuracy. The proposed method is initially tested on the iris data set with regard to different predefined fuzzy partitions of linguistic variables to assess its performance. Experimental results demonstrate that the proposed approach is not sensitive to the predefined fuzzy partitions, and can boost classification performance especially when a coarse fuzzy partition is given.

Session 5: Advances and Applications of Evolutionary Computing and Optimization

A Benchmark Generator for Dynamic Multi-objective Optimization Problems
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Abstract—Many real-world optimization problems appear to not only have multiple objectives that conflict each other but also change over time. They are dynamic multi-objective optimization problems (DMOPs) and the corresponding field is called dynamic multi-objective optimization (DMO), which has gained growing attention in recent years. However, one main issue in the field of DMO is that there is no standard test suite to determine whether an algorithm is capable of solving them. This paper presents a new
benchmark generator for DMOPs that can generate several complicated characteristics, including mixed Pareto-optimal front (convexity-concavity), strong dependencies between variables, and a mixed type of change, which are rarely tested in the literature. Experiments are conducted to compare the performance of five state-of-the-art DMO algorithms on several typical test functions derived from the proposed generator, which gives a better understanding of the strengths and weaknesses of these tested algorithms for DMOPs.

PermGA Algorithm for a Sequential Optimal Space Filling DoE Framework
Mohammed Reza Kianifar, Felician Campean and Alastair Wood
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Abstract — This paper presents the development and implementation of a customised Permutation Genetic Algorithm (PermGA) for a sequential Design of Experiment (DoE) framework based on space filling Optimal Latin Hypercube (OLH) designs. The work is motivated by multivariate engineering problems such as engine mapping experiments, which require efficient DoE strategies to minimise expensive testing. The DoE strategy is based on a flexible Model Building – Model Validation (MB-MV) sequence based on space filling OLH DoEs, which preserves the space filling and projection properties of the DoEs through the iterations. A PermGA algorithm was developed to generate MB OLHs, subsequently adapted for generation of infill MV test points as OLH DoEs, preserving good space filling and projection properties for the merged MB + MV test plan. The algorithm was further modified to address issues with non-orthogonal design spaces. A case study addressing the steady state engine mapping of a Gasoline Direct Injection was used to illustrate and validate the practical application of MBMV sequence based on the developed PermGA algorithm.

Hybridisation of Decomposition and GRASP for Combinatorial Multiobjective Optimisation
Ahmad Alhindi, Qingfu Zhang and Edward Tsang
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Abstract—This paper proposes an idea of using heuristic local search procedures specific for single-objective optimisation in multiobjective evolutionary algorithms (MOEAs). In this paper, a multiobjective evolutionary algorithm based on decomposition (MOEA/D) hybridised with a multi-start single-objective metaheuristic called greedy randomised adaptive search procedure (GRASP). In our method a multiobjective optimisation problem (MOP) is decomposed into a number of single-objective subproblems and optimised in parallel by using neighbourhood information. The proposed GRASP alternates between subproblems to help them escape local Pareto optimal solutions. Experimental results have demonstrated that MOEA/D with GRASP outperforms the classical MOEA/D algorithm on the multiobjective 0-1 knapsack problem that is commonly used in the literature. It has also demonstrated that the use of greedy genetic crossover can significantly improve the algorithm performance.

Dynamic Railway Junction Rescheduling using Population Based Ant Colony Optimisation
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Abstract—Efficient rescheduling after a perturbation is an important concern of the railway industry. Extreme delays can result in large fines for the train company as well as dissatisfied customers. The problem is exacerbated by the fact that it is a dynamic one;
more timetabled trains may be arriving as the perturbed trains are waiting to be rescheduled. The new trains may have different priorities to the existing trains and thus the rescheduling problem is a dynamic one that changes over time.

The aim of this research is to apply a population-based ant colony optimisation algorithm to address this dynamic railway junction rescheduling problem using a simulator modelled on a real-world junction in the UK railway network. The results are promising: the algorithm performs well, particularly when the dynamic changes are of a high magnitude and frequency.

**Adaptive Mutation in Dynamic Environments**

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*Benjamin N. Passow*

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Abstract—The interest in nature inspired optimization in dynamic environments has been increasing constantly over the past years. This trend implies that many real world problems experience dynamic changes and it is important to develop an efficient algorithm capable of tackling these problems. Several techniques have been developed over the past two decades for solving dynamic optimization problems. Among these techniques, the hypermutation scheme has proved to be beneficial in solving some of the dynamic optimization problems but requires that the mutation factors be picked a priori.

This paper investigates a new mutation and change detection scheme for compact genetic algorithm (cGA), where the degree of change regulates the mutation rate (i.e. mutation rate is directly proportional to the degree of change). The experimental results shows that the mutation and change detection scheme has an impact on the performance of the cGA in dynamic environments and that the effect of the proposed scheme depends on the dynamics of the environment.

**Poster Session**

**Crowd Formal Modelling and Simulation: The Sa’yee Ritual**

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Abstract—There is an increasing interest in modelling of agents interacting as crowd and a simulation of such scenarios that map to real-life situations. This paper presents a generic state-based abstract model for crowd behaviour that can be mapped onto different agent-based systems. In particular, the abstract model is mapped into the simulation framework NetLogo. We have used the model to simulate a real-life case study of high density diverse crowd such as the Hajj ritual at the mosque in Mecca (Makkah). The computational model is based on real data extracted from videos of the ritual. We also present a methodology for extracting significant data, parameters, and patterns of behaviour from real-world videos that has been used as an early stage validation to demonstrate that the obtained simulations are realistic.
Soft Morphological Filter Optimization Using a Genetic Algorithm for Noise Elimination

Turker Ercal

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Ender Ozcan and Shahriar Asta

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Abstract—Digital image quality is of importance in almost all image processing applications. Many different approaches have been proposed for restoring the image quality depending on the nature of the degradation. One of the most common problems that cause such degradation is impulse noise. In general, well known median filters are preferred for eliminating different types of noise. Soft morphological filters are recently introduced and have been in use for many purposes. In this study, we present a Genetic Algorithm (GA) which combines different objectives as a weighted sum under a single evaluation function and generates a soft morphological filter to deal with impulse noise, after a training process with small images. The automatically generated filter performs better than the median filter and achieves comparable results to the best known filters from the literature over a set of benchmark instances that are larger than the training instances. Moreover, although the training process involves only impulse noise added images, the same evolved filter performs better than the median filter for eliminating Gaussian noise as well.

A Rule Based System for Diagnosing and Treating Chronic Heart Failure

Luke Vella Critien, Arjab Singh Khuman, Jenny Carter and Samad Ahmadi

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Abstract—The aim of this study is to design a rule based expert system which provides doctors with a better tool to be able to manage chronic heart failure in adults. The suggested system is intended to help in diagnosing heart failure at the earliest permissible stage and subsequently suggest the best treatment for the particular case. The designed system has two facets, one related to the diagnosis and the other related to the treatment of chronic heart failure. The former part is based on the latest chronic heart failure guidelines issued by the National Health Services (NHS) - National Institute for Health and Clinical Excellence (NICE) in August 2010. The treatment for chronic heart failure is based on the latest version of British National Formulary (BNF). This rule based system is not intended to replace the specialist but it may be used to provide assurance that all diagnostic criteria have been followed and hence the best possible treatment is given. The system is implemented using the CLIPS language which is a powerful forward-chaining rule based system.

Computational Techniques for Identifying Networks of Interrelated Diseases

Ken McGarry and Ukeme Daniel

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Abstract—Recently there has been a lot of interest in using computational techniques to build networks of protein-to-protein interactions, interacting gene networks and metabolic reactions. Many interesting and novel discoveries have been made using graph based structures using links and nodes to represent the relationships between proteins and genes. Analysis of graph networks has revealed that genes and proteins cooperate in modules performing specific functions and that there is crosstalk or overlap between modules. In this paper we take these ideas further and build upon current knowledge to build up a network of human related diseases based on graph theory and the concept
of overlap or shared function. We explore the hypothesis that many human diseases are linked by common genetic modules, therefore a defect in one of any of the cooperating genes in a module may lead to a specific disease or related symptom. We build our networks using data and information extracted from several online databases along with supporting knowledge in the form of biological ontologies.

**Word Order Variation and String Similarity Algorithm to Reduce Pattern Scripting in Pattern Matching Conversational Agents**

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Abstract—This paper presents a novel sentence similarity algorithm designed to mitigate the issue of free word order in the Urdu language. Free word order in a language poses many challenges when implemented in a conversational agent, primarily due to the fact that it increases the amount of scripting time needed to script the domain knowledge. A language with free word order like Urdu means a single phrase/utterance can be expressed in many different ways using the same words and still be grammatically correct. This led to the research of a novel string similarity algorithm which was utilized in the development of an Urdu conversational agent. The algorithm was tested through a black box testing methodology which involved processing different variations of scripted patterns through the system to gauge the performance and accuracy of the algorithm with regards to recognizing word order variations of the related scripted patterns. Initial testing has highlighted that the algorithm is able to recognize legal word order variations and reduce the knowledge base scripting of conversational agents significantly. Thus saving great time and effort when scripting the knowledge base of a conversational agent.

**Automatic Image Annotation with Long Distance Spatial-Context**

Donglin Cao, Dazhen Lin and Jiansong Yu

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Abstract—Motion state change object detection, such as stopped objects detection, is one of important topics in Video Surveillance Systems. Generally, backgrounds in the most Video Surveillance Systems have the property of pureness and selfsimilarity. In this paper, we propose a block background context based background model to solve the motion state change problem. Unlike the classical background model, our approach first models blocks of background, and then determines the learning rate of each block background model by using the block background context information. There are two main advantages. First, the model adaptively selects the learning rate for each block of background model, and that is more flexible than the adaptive learning rate for the whole background. Second, context information helps the determination of true foreground and brings in more reliable information in foreground detection. Our experiments results show that our model outperforms the higher and lower learning rate Gaussian mixture background model in motion state change object detection.

**PCA-based Algorithmic Approximation of Crisp Target Sets**

Ray-Ming Chen

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Abstract—Principal Component Analysis (PCA) is an important technique in finding uncorrelated variables. It is applied in many fields: machine learning, pattern recognition, data mining, compression, etc. In this paper, we introduce this technique into approximation reasoning. Before the introduction, we construct a theoretical framework of such approximation first. This approximation is based on reasoning of incomplete information in which there exists no algorithm such that the intersection between arbitrary target sets and partitioned clusters is decidable, while there exist some algorithms for the decidability of the subset operation between them. Then, under this framework, we utilize PCA to implement such approximation reasoning. PCA is mainly applied to partitioning a universe repeatedly until all the partitioned sets are singular or indecomposable. Then we collect all the partitioned clusters as the granular knowledge and then use this knowledge to approximate the target set.

Optimized Artificial Neural Network Using Differential Evolution for Prediction of RF Power in VHF/UHF TV and GSM 900 Bands for Cognitive Radio Networks
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Abstract—Cognitive radio (CR) technology has emerged as a promising solution to many wireless communication problems including spectrum scarcity and underutilization. The knowledge of Radio Frequency (RF) power (primary signals and/or interfering signals plus noise) in the channels to be exploited by CR is of paramount importance, not just the existence or absence of primary users. If a channel is known to be noisy, even in the absence of primary users, using such channels will demand large quantities of radio resources (transmission power, bandwidth, etc) in order to deliver an acceptable quality of service to users. Computational Intelligence (CI) techniques can be applied to these scenarios to predict the required RF power in the available channels to achieve optimum Quality of Service (QoS). While most of the prediction schemes are based on the determination of spectrum holes, those designed for power prediction use known radio parameters such as signal to noise ratio (SNR), bandwidth, and bit error rate. Some of these parameters may not be available or known to cognitive users. In this paper, we developed a time domain based optimized Artificial Neural Network (ANN) model for the prediction of real world RF power within the GSM 900, Very High Frequency (VHF) and Ultra High Frequency (UHF) TV bands. The application of the models produced was found to increase the robustness of CR applications, specifically where the CR had no prior knowledge of the RF power related parameters. The models used implemented a novel and innovative initial weight optimization of the ANN’s through the use of differential evolutionary algorithms. This was found to enhance the accuracy and generalization of the approach.

Truss Topology Optimization with Species Conserving Genetic Algorithm
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Abstract — This paper is to apply the species conserving genetic algorithm (SCGA) to search multiple solutions of truss topology optimization problems in a single run. A real-vector is used to represent the corresponding cross-sectional areas and a member is thought to be existent if its area is bigger than a critical area. A finite element analysis
model has been developed to deal with more practical considerations in modeling, such as existences of members, kinematic stability analysis and the computation of stresses and displacements. Cross-sectional areas and node connections are taken as decision variables and optimized simultaneously to minimize the total weight of trusses. Numerical results demonstrate that some truss topology optimization examples have many global and local solutions and different topologies can be found by using the proposed algorithm in a single run and some trusses have smaller weight than the solutions in the literature.

The Effect of Attribute Pairings in Intrusion Detection
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Abstract—As Network Intrusions have become larger and more pervasive the methods of detection have changed, a number of systems use ensemble methods to improve upon results from single classifiers or algorithms. The solutions proposed in the literature achieve good results, which primarily focus on classification of Network Intrusions by tailoring classification algorithms and feature selection. However fewer studies focus on investigation of relation between pairs of attributes, such as IP address and Port, as a single attribute. This paper proposes an effect analysis of pairs of attributes in order to improve intrusion detection using an ensemble-based classification approach.

Towards Automated Monitoring of Adult Zebrafish
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Abstract—Over the last two decades, zebrafish (Danio rerio) have emerged as an efficient model to aid in the research of a broad range of human diseases as well as such diverse applications as environmental modelling and drug discovery. Economically, the large number, low price and low maintenance requirements of this fish species encouraged its use for research. In addition to this, the study of zebrafish is being used to improve the understanding of fish physiology, with implications for fish welfare. In order to thoroughly model the behaviour, development and growth of these fish, it is important to be able to scrutinise the characteristics of individual fish as they respond to a range of stimuli, and to this end off-line fish recognition and on-line tracking using video data is employed. Tracking and identifying such small and fast-moving objects is a challenge, and this paper seeks to address this using a behavioural analysis approach. Utilising single high resolution camera and two low-cost synchronised video cameras, the proposed systems captures front (face) and side (profile) pictures of each isolated fish as they swim past a given marker. The acquired images are then subject to three separate processing routes in order to satisfy three complementary but distinct objectives. Initially, fish face and profile features are extracted to aid the identification of individual fish. Then, for each fish identified, behavioural features such as the frequency and intensity of the operculum beat rate or breathing cycle are quantified in order to assess aspects of the fish welfare. Additionally, the volume of each fish is estimated based on its profile dimensions, enabling the weight of the fish to be monitored throughout its lifetime. This paper presents
preliminary experimental considerations and findings of this on-going research project. Results to date have been both encouraging and promising, validating the approach and the experimental configuration adopted.

**Improving Motion State Change Object Detection by Using Block Background Context**

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Abstract—Motion state change object detection, such as stopped objects detection, is one of important topics in Video Surveillance Systems. Generally, backgrounds in the most Video Surveillance Systems have the property of pureness and selfsimilarity. In this paper, we propose a block background context based background model to solve the motion state change problem. Unlike the classical background model, our approach first models blocks of background, and then determines the learning rate of each block background model by using the block background context information. There are two main advantages. First, the model adaptively selects the learning rate for each block of background model, and that is more flexible than the adaptive learning rate for the whole background. Second, context information helps the determination of true foreground and brings in more reliable information in foreground detection. Our experiments results show that our model outperforms the higher and lower learning rate Gaussian mixture background model in motion state change object detection.

**Session 6: Intelligent Technologies for Healthcare and Behaviour Analysis**

An Efficient System For Preprocessing Confocal Corneal Images For Subsequent Analysis

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Abstract— A confocal microscope provides a sequence of images of the various corneal layers and structures at different depths from which medical clinicians can extract clinical information on the state of health of the patient’s cornea. Preprocessing the confocal corneal images to make them suitable for analysis is very challenging due the nature of these images and the amount of the noise present in them. This paper presents an efficient preprocessing approach for confocal corneal images consisting of three main steps including enhancement, binarisation and refinement. Improved visualisation, cell counts and measurements of cell properties have been achieved through this system and an interactive graphical user interface has been developed.

Human Activity Classification Using A Single Accelerometer

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Abstract—Human activity recognition is an area of growing interest facilitated by the current revolution in body-worn sensors. Activity recognition allows applications to construct activity profiles for each subject which could be used effectively for healthcare and safety applications. Automated human activity recognition systems face several challenges such as number of sensors, sensor precision, gait style differences, and others. This work proposes a machine learning system to automatically recognise human activities based on a single body-worn accelerometer. The in-house collected dataset contains 3D acceleration of 50 subjects performing 10 different activities. The dataset was produced to ensure robustness and prevent subject-biased results. The feature vector is derived from simple statistical features. The proposed method benefits from RGB-to-YIQ colour space transform as kernel to transform the feature vector into more discriminable features. The classification technique is based on an adaptive boosting ensemble classifier. The proposed system shows consistent classification performance up to 95% accuracy among the 50 subjects.

Multiple sensor outputs and computational intelligence towards estimating state and speed for control of lower limb prostheses

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Abstract—For as long as people have been able to survive limb threatening injuries prostheses have been created. Modern lower limb prostheses are primarily controlled by adjusting the amount of damping in the knee to bend in a suitable manner for walking and running. Often the choice of walking state or running state has to be controlled manually by pressing a button. This paper examines how this control could be improved using sensors attached to the limbs of two volunteers. The signals from the sensors had features extracted which were passed through a computational intelligence system. The system was used to determine whether the volunteer was walking or running and their movement speed. Two new features are presented which identify the movement states of standing, walking and running and the movement speed of the volunteer. The results suggest that the control of the prosthetic limb could be improved.

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Blood-Glucose Pattern Mining Algorithm for Decision Support in Diabetes Management

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Abstract—Pattern recognition has been an effective approach to identifying glycaemic patterns within self-monitored blood glucose (BG) data in diabetes mellitus patients. This paper presents a new BG pattern mining algorithm for more targeted therapeutic decision support in diabetes self-management. Based on patients’ BG readings which are collected via a handheld device and logged on a web-based health portal, the existing BG patterns are extracted in real-time and fed back to the patient along with appropriate therapeutic recommendations, educational modules and health care advice. The identified patterns help patients improve their blood glucose management and education about diabetes and
its complications. A functional prototype of the proposed system is developed and its end-to-end functionality is successfully demonstrated. A pilot clinical study demonstrated positive user acceptability and interest in its decision support attributes for diabetes self-management, making this a promising avenue for further research.

Integrated Microarray Analytics for the Discovery of Gene Signatures for Triple-Negative Breast Cancer
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Abstract—Triple-negative breast cancers (TNBC) are clinically heterogeneous, an aggressive form of breast cancer with poor diagnosis and highly therapeutic resistant. It is urgently needed for identifying novel biomarkers with increased sensitivity and specificity for early detection and personalized therapeutic intervention. Microarray profiling offered significant advances in molecular classification but sample scarcity and cohort heterogeneity remains challenging areas. Here, we investigated diagnostics signatures derived from human triplenegative tissue. We applied REMARK criteria for searching for relevant studies and compared the eligible signatures by assessing their classification power for diagnosis using leave-one-out crossvalidation. The cross-validation shows excellent classification accuracy ratios achieved for diagnosis using all the data sets. A subset signature (17-gene) extracted from the convergence of eligible signatures also achieved good classification accuracy of 89.37% across all data sets. We also applied gene ontology functional enrichment analysis to extract potentially common biological process, pathways and network involved in TNBC disease progression. Through functional analysis, we recognized that these independent signatures have displayed commonalities in functional pathways of cell signaling, which play important role in the development and progression of TNBC. We have also identified five unique TNBC pathways genes (SYNCRIP, NFIB, RGS4, UGCG, LOX and NNMT), which could be important for therapeutic interventions as indicated by their close association with known drivers of TNBC and previously published experimental studies.

Prediction of Driver Fatigue: Approaches and Open Challenges
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Abstract—Fatigue is a mental process that grows gradually and affects human reaction time and the consciousness. It is one of the causes of road fatal accidents around the globe. Although it is now generally accepted that fatigue plays an important role in road safety, it is still largely left to individual drivers to manage. The recent research in this area focuses on fatigue detection and the existing systems alert the drivers in severe fatigued stage. These systems use either physiological signs of the fatigue or the behavioural reaction to generate alerts. This research investigates the feasibility of using a group of fatigue symptoms (such as pupil response, gaze patterns, steering reaction and EEG) to build a robust fatigue detection algorithm that can be used in a real life system for the early prediction and avoidance of fatigue development. Intensive testing and validation stages are required to ensure the reliability and the suitability of the system that should be able to detect fatigue levels at different degrees of tiredness. Moreover, the proposed system
predicts subsequent stages of fatigue and generates an approximate behavioural model for each individual driver to enable more personalized and effective intervention.

Using Computational Methods for the Prediction of Drug Vehicles
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Abstract—Drug vehicles are chemical carriers that aid a drug’s passage through an organism. Whilst they possess no intrinsic efficacy they are designed to achieve desirable characteristics which can include improving a drug’s permeability and or solubility, targeting a drug to a specific site or reducing a drug’s toxicity. All of which are ideally achieved without compromising the efficacy of the drug. Whilst the majority of drug vehicle research is focused on the solubility and permeability issues of a drug, significant progress has been made on using vehicles for toxicity reduction. Achieving this can enable safer and more effective use of a potent drug against diseases such as cancer. From a molecular perspective, drugs activate or deactivate biochemical pathways through interactions with cellular macromolecules resulting in toxicity. For newly developed drugs such pathways are not always clearly understood but toxicity endpoints are still required as part of a drug’s registration. An understanding of which vehicles could be used to ameliorate the unwanted toxicities of newly developed drugs would be highly desirable to the pharmaceutical industry. In this paper we demonstrate the use of different classifiers as a means to select vehicles best suited to avert a drug’s toxic effects when no other information about a drug’s characteristics is known. Through analysis of data acquired from the Developmental Therapeutics Program (DTP) we are able to establish a link between a drug’s toxicity and vehicle used. We demonstrate that classification and selection of the appropriate vehicle can be made based on the similarity of drug choice.