## Contents

Welcome ................................. 3
The LANCS Initiative ....................... 4
Heuristic Understanding .................... 5
Systems to Build Systems ................. 5
Next Generation Decision Support
Automating the heuristic design process 6
The Cross-domain Heuristic Search Challenge: An International Research Competition 8
Educational Timetabling .................... 9
Sports Timetabling .......................... 10
Cutting and Packing ....................... 11
Improving Airport and Airline Operations 12
Personnel Rostering and Healthcare ...... 14
Outreach ..................................... 16
Conference Organisation ................... 17
Spin Out Companies ....................... 18
Professional Activities ..................... 19
Publications (2009-2010) .................. 24
Grants ....................................... 34
ASAP Personnel ............................. 38
Visiting Fellows/Associate Staff .......... 42
Former Members ............................ 42
How to Find Us ............................. 43
Welcome to our 2009-2011 research report. Over this period, the Automated Scheduling, Optimisation and Planning (ASAP) group has strengthened its position as one of the leading research groups in the world in computational search methodologies.

Throughout the period our aim was to set the following research directions on the international agenda:

- Modelling the complexity and uncertainty inherent in complex, real-world problems across a wide range of application areas including airport optimization, cutting and packing, educational timetabling, healthcare, network routing, personnel scheduling, portfolio optimization, production scheduling/rescheduling, public transport optimization, space allocation, transportation logistics optimization and vehicle routing.
- Developing intelligent systems that can automatically aid the design and implementation of more efficient, effective, reusable, easier-to-implement/deploy/use general computational search methods that are applicable to a range of real-world problems.
- Developing rigorous mathematical theories for a more profound understanding of real world problems and effective design of intelligent decision support systems.

Our expertise in Computer Science and Operational Research allows us to bring a unique and novel perspective to traditional Operational Research problems, and also to bring new real-world problems to the Computer Science community.

The Engineering and Physical Sciences Research Council (EPSRC) funded Platform Grant will help further the group to continue carrying out world leading research. One of the key motivations for Platform awards is to underpin internationally outstanding research teams by providing funding that can be flexibly managed to bridge the gaps between externally funded projects. ASAP were awarded a Platform Grant in 2004. In 2010, this grant was renewed to the value of just over £1M. This renewal of our platform funding recognises the international leadership of the group and provides the group with a level of financial stability that will enable us to address our key research themes over the next few years.

We continue our research work on the EPSRC funded Science and Innovation Grant, LANCS, which supports collaboration between four leading Operational Research groups in the U.K. (Lancaster, Nottingham, Cardiff, Southampton).

The launch of Staff Roster Solutions Ltd in 2010 saw the establishment of our third spin out company. This underlines our commitment to addressing scientific challenges that are derived from industrial requirement. We have published research results in many of the leading journals in the world in Operational Research and Computer Science. Our research achievements over this period are outlined in this report.

Professor Edmund Burke left the group in December 2011 to take a new appointment as Pro-vice Chancellor for Research at the University of Stirling. His leadership of ASAP has been exemplary. Professor Sanja Petrovic moved into the role of the head of the group.

We are very happy to provide more detail if you have any further questions. Our contact details are given at the end of the report.
The LANCS Initiative is a collaboration between four of the leading Operational Research (OR) groups in the UK. Specifically, the four universities involved are:

LA  Management School, Lancaster University
N   School of Computer Science, University of Nottingham
C   School of Mathematics, Cardiff University
S   School of Mathematics and School of Management, University of Southampton

This collaboration represents a funding programme of over £13M. It is supported through the EPSRC’s Science and Innovation initiative, with £5.4M being provided by EPSRC and the remainder from the four universities. As far as we are aware, this is the largest Operational Research grant in the world. The Initiative started in September 2008 and is expected to have a significant influence on the development of OR within the UK, and, indeed, across the world.

According to EPSRC’s 2004 International Review of OR, the UK has a strong position in the practical application of OR. However, in the wider community, there has generally been a ‘gap’ between the theory and the practice. A primary goal of the LANCS Initiative is to close this gap, and to contribute towards building UK capacity in OR by setting the overall long-term national and international research agenda. That is, it has the aim of building the theory of OR in order to support the practice of OR.

The LANCS initiative is organised around six research clusters. Two of these are concerned with application areas that are vital to the UK: Transport and Logistics, and Healthcare. The remaining four clusters are concerned with important theoretical research directions: Discrete Nonlinear Optimisation, Stochastic Modelling, Heuristic Understanding and Systems to Build Systems, with the last two being led by Nottingham. These two Nottingham-led themes are explored in more detail on the opposite page. It is important to note though that Nottingham plays a key role across the whole of the LANCS initiative.
Many real-world problems are too large for classical exact optimisation methods to be employed. However, good quality solutions can often be obtained by the use of carefully chosen heuristics and meta-heuristics. A heuristic can be thought of as a “rule of thumb”. It is a program that returns a solution which is (hopefully) of good quality but there is no guarantee of optimality. Many different heuristic methods are available, and selecting the best one (or even a combination of heuristics) is often carried out by a human expert drawing upon years of experience. However, there is generally a lack of a deep understanding as to why and when they work, with the result that significant expensive expertise and time-consuming experimentation is often required to put them into practice. The aim of this research cluster is to strengthen the theoretical understanding of how heuristics work so as to reduce the need for trial and error. Expensive mistakes (in terms of both time and resources) can be avoided and engineering efforts can be directed in more fruitful directions.

Research is currently progressing towards developing a deeper understanding of the relationships between the choices of heuristics and the underlying structures of problem instances. In particular, many problems exhibit threshold behaviours in which their properties can change rapidly as problem features are changed. Cutting-edge novel research, into what we term “Parametric Parameter Tuning,” is investigating the mathematical properties of such thresholds in speeding up the process of matching algorithms and control parameters to the problem instances. As another example, recent work has built Markov chain models of a state-of-the-art algorithm in order to develop a deeper understanding of why it performs so well, with a view to improving performance even further.

Building an effective decision support system can often be a rather overwhelming and expensive task. There are not many tools available, the experience of an expert is often needed and, even for an expert, there is usually a time-consuming phase of trial and error. These difficulties often mean that only large organisations have the resources to develop or purchase such systems and benefit from the potential efficiency savings. This often means that computational techniques are effectively unavailable to small and medium sized enterprises even though they form a large part of the national economy.

The aim of this theme is to develop the theoretical understanding required to underpin the construction of tools and components to allow decision support systems to be built automatically and to enable them to adapt quickly to changing circumstances. The idea is to effectively capture much of the role that normally requires a human optimisation or computational search expert. Work on this challenging goal, which is being addressed in close cooperation with the heuristics understanding theme, is developing the mathematical and theoretical understanding of how to build general-purpose intelligent systems which are capable of supporting the faster and cheaper construction of new decision support systems for Small and Medium Enterprises and others.
Next Generation Decision Support
Automating the heuristic design process

This project represents a £2.6M investment from EPSRC. The project research team is working closely with colleagues on the ‘Systems to Build Systems’ cluster of the LANCS Initiative (see the previous page). Indeed this project represents the ‘applied’ direction of this key strategic theme whilst the LANCS Initiative provides the theoretical direction. By working closely together, we can answer that the theory is informed by the practice and vice versa. Heuristic search methods have been successful in solving difficult real-world optimisation problems. Diverse methodologies have been proposed in Computer Science, Artificial Intelligence, and Operational Research, ranging from bio-inspired approaches to the randomisation of complete methods. However, successful heuristics need to be crafted anew for each new problem, or even just a new instance of the same problem. The goal of this project is to reduce the role of the human expert in designing effective search.
Problem Domains

HyFlex appeals to the modular design of search heuristics, and the idea of a controlled separation between the problem-specific and the general-purpose algorithm components. These components are reusable and interchangeable through the HyFlex interface.

“Successful heuristics need to be crafted anew for each new problem, or even just a new instance of the same problem.”

We have identified two approaches in addressing this challenge: heuristic selection, and heuristic generation. In heuristic selection, the idea is to automatically combine fixed pre-defined heuristics or neighbourhood structures to solve the problem at hand; whereas in heuristic generation the idea is to automatically create new heuristics (or heuristic components). ASAP has developed these two lines of research. An example of heuristic generation is the evolution using genetic programming of flexible packing heuristics that can generalise from one-dimensional to three-dimensional problems. Our heuristic selection research, which has been going on for about ten years, has recently seen the release of HyFlex (Hyper-heuristics Flexible framework), a Java object oriented framework for the implementation and comparison of different iterative general-purpose heuristic search algorithms (also called hyper-heuristics). The framework appeals to modularity and is inspired by the notion of a domain barrier between the low-level heuristics and the hyper-heuristic. It provides a software interface between the hyper-heuristic and the problem domain layers, thus enabling a clearly defined separation, and communication protocol between the domain specific and the domain independent algorithm components. HyFlex has led to the international challenge, the first Cross-domain Heuristic Search Challenge (CHeSC 2011), which has already gathered the attention of recognised researchers in the area of adaptive search heuristics.
The Cross-domain Heuristic Search Challenge differed from other competitions in search and optimisation, as it aimed to measure performance over several problem domains rather than just one. We have been developing a software framework featuring a common software interface (HyFlex) for dealing with different combinatorial optimisation problems. HyFlex provides the algorithm components that are problem specific. In this way, we simultaneously liberate algorithm designers from needing to know the details of the problem domains; and prevent them from incorporating additional problem specific information in their algorithms. Efforts can instead be focused on designing high-level strategies to intelligently combine the provided problem-specific algorithmic components.

The competition was organised and run by the ASAP group; with contributions from Queen’s University, Belfast, UK; Cardiff University, UK; and the Ecole Polytechnique, Montreal, Canada. It was financially supported by the PATAT conference series, Aptia Solutions Ltd, EventMap Ltd and Staff Roster Solutions Ltd (see Spinout Companies section). Mustafa Mısır, a PhD student from University KaHo Sint-Lieven, Belgium with his adaptive hyper-heuristic approach won the competition.

The challenge evaluated the performance of the competing algorithms, not only across several problem instances, but also across several domains including the Travelling Salesman Problem and Vehicle Routing Problem domains.

The overall scores for the top 3 algorithms are as follows:

<table>
<thead>
<tr>
<th>Algorithm Name</th>
<th>Score</th>
<th>Author/Team</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>AdapHH</td>
<td>181</td>
<td>Mustafa Mısır</td>
<td>University KaHo Sint-Lieven, Belgium</td>
</tr>
<tr>
<td>VNS-TW</td>
<td>134</td>
<td>Ping-Che Hsiao</td>
<td>National Taiwan University, Taiwan</td>
</tr>
<tr>
<td>ML</td>
<td>131.5</td>
<td>Mathieu Larose</td>
<td>Université de Montréal, Canada</td>
</tr>
</tbody>
</table>

SAT Instance 1:
- HH1 - 34
- HH2 - 23
- HH3 - 27
- HH4 - 10
- HH5 - 30

The challenge evaluated the performance of the competing algorithms, not only across several problem instances, but also across several domains including the Travelling Salesman Problem and Vehicle Routing Problem domains.
Educational timetabling requires the efficient allocation of events to resources whilst respecting a wide range of constraints and preferences arising from personal, institutional, governmental requests, rules and regulations. Timetabling remains a research challenge for both researchers and practitioners due to its difficulty and complexity. ASAP has been at the leading position of developing advanced algorithms and search methodologies, in addition to intelligent decision support systems in timetabling for over 15 years.

Research issues and topics of particular interest to ASAP include the following:

- The modelling of educational timetabling problems with real world complexities and constraints
- The development of advanced decision support systems, supported by intelligent computational search methodologies, including heuristics, meta-heuristics, hyper-heuristics and their hybridisations
- The investigation and development of advanced algorithms, including meta-heuristics and hyper-heuristics in order to underpin the next generation of general and adaptive timetabling algorithms
- The integration of exact methods, such as integer linear programming and constraint programming, with meta-heuristics for solving large and highly constrained timetabling problems

ASAP has been co-organising the conference series on the Practice and Theory of Automated Timetabling (PATAT) since 1995. The biennial PATAT conferences have been a forum for both researchers and practitioners to exchange ideas about real world timetabling and advanced decision support solutions.

ASAP also co-organised the second International Timetabling Competition 2007, held in collaboration with Queen’s University Belfast, Cardiff University, Edinburgh Napier University and the University of Udine. Successful approaches on both course and exam timetabling tracks from researchers around the world have been published at the PATAT2008 conference.

In addition, ASAP plays a leading role in the Association of European Operational Research Societies (EURO) Working Group on Automated Timetabling (WATT), which was established in 1996. Workshops organised in alternating years within the EURO and IFORS conferences have attracted researchers and practitioners in timetabling to exchange their ideas and opinions.

In addition to organising international events, EventMAP Ltd has been spun out from Queen’s University Belfast and the University of Nottingham to provide automated solutions to timetabling problems.
Sports Timetabling

Sports timetabling underpins a wide variety of scheduling problems, from high profile televised events to local amateur and children’s leagues. The importance of high quality scheduling is sometimes overlooked until the effects of poor scheduling become apparent. For example, a press report from 2005 said,

“Football supporters and motoring organisations have called for changes in the scheduling of fixtures (over the Christmas holiday period) to prevent supporters from having to drive home from matches well into the early hours of the morning.”

The Times (Sport, Football), 30th December 2005, page 68

In fact, the Football Association already attempt to minimise the distances that have to be travelled by football supporters over the holiday period. However, ASAP has started preliminary work on developing methodologies to address these issues.

Indeed, we have had contact with London Metropolitan police to establish how policing constraints influence the real world specification of the problem.

We are also working with a local company (League Republic) who provides amateur leagues with a service to schedule their fixtures through a web interface. This type of timetabling raises many challenges such as ground sharing and constraints on parents who have to transport their children to the various locations.

“Football supporters and motoring organisations have called for changes in the scheduling of fixtures (over the Christmas holiday period) to prevent supporters from having to drive home from matches well into the early hours of the morning.”

The Times (Sport, Football), 30th December 2005, page 68
Cutting and packing impacts many different industries and is primarily concerned with identifying the most efficient way to utilise resources, material or space. Examples include the textile industry, where clothing pieces must be cut from a roll of fabric, international logistics where products are arranged in containers for shipping, and the optimisation of print layout where images are arranged before printing on a substrate.

For many industries, even a small reduction in material requirements can give significant accumulated savings over time as the job is cut again and again. However, better use of material.space not only yields significant cost savings but also reduces the impact on the environment as less resources are required to meet production demand (or in the case of shipping containers, space is used more efficiently thus reducing the number of journeys required).

ASAP has conducted research into cutting and packing problems for over fifteen years and has published many of the best performing heuristic, meta-heuristic and hyper-heuristic algorithms for both 2-dimensional and 3-dimensional problems over that period. Our published approaches obtain many of the best-known solutions for a number of internationally recognised benchmark problems and are widely cited within the literature.

In light of ASAP’s success in this field, Aptia Solutions (a spin-out company) was formed to further develop these approaches and to explore commercialisation opportunities. Aptia has developed a number of products, each targeting a different industry or application. Aptia has also developed a novel way of delivering its software as a pay-as-you-go service to give access to individuals and small businesses who, traditionally, have not been able to afford the large upfront cost associated with this kind of software. Currently, Aptia has many customers using its products and services including a number of high profile clients in construction, print and graphics, aerospace and Formula One racing.
Improving Airport and Airline Operations

The modern air transportation system is a complex environment, where many different optimisation and search problems have to be solved every day. The ASAP research group have been working with airports to understand their operations and to consider where optimisation and increased automation of planning could potentially help to improve overall system performance. Meanwhile, we have simultaneously been working with airlines, seeking to increase the understanding of the causes of and propagation of delays, with an aim to being able to produce more robust flight schedules.

In 2009, London Heathrow was the busiest airport in Europe and the second busiest in the world. It had more international passengers flowing through it each year than any other airport, despite having only two runways in daily use. In contrast, Paris-Charles de Gaulle has four runways. The limited number of runways means that obtaining a high runway utilisation is extremely important if delays are to be kept low and the take-off sequence has a huge effect upon the runway throughput. Our work at Heathrow has been funded by EPSRC and NATS (formerly National Air Traffic Services) Ltd, through the Smith Institute for Industrial Mathematics. We
have considered the problem of providing realistic decision support to the controllers who sequence the take-offs from Heathrow. By harnessing the power and flexibility of modern computational search techniques, ASAP were able to build an algorithm which could make the decisions to underpin such a decision support system for the runway controllers, and to do so quickly enough that it could respond immediately to ongoing situational changes (finding answers to new problems within a second). Despite the complexity of the problem, it is currently solved manually by a runway controller in the control tower at Heathrow. Although the NATS controllers perform excellently (simulations indicate that delays would be over four times as long without the re-sequencing performed by the controllers), with up to one take-off a minute, there is insufficient time for controllers to consider all possible good take-off sequences and results predicted considerable benefits from providing the controllers with decision support to consider more aircraft and to consider them sooner.

A second research project for Heathrow, again funded by NATS and EPSRC, is considering the problem of predicting the take-off sequence while aircraft are still at the stands/gates. By predicting the delay that an aircraft will have, it is then possible to absorb some of this delay at the stands rather than the runway, starting the engines later, saving fuel with commensurate environmental and economic benefits. NATS are currently integrating the system into a larger BAA system at Heathrow.

ASAP has also worked closely with Air-France-KLM to investigate new approaches to build more robust schedules. The approach implemented minor changes to existing schedules, aiming to improve robustness and reduce passenger delays. A more robust schedule is one that is less sensitive to disruptions on the day of operation, offers increased flexibility to recover from disruptions, and prevents delay propagation through increased schedule stability. The approach developed by ASAP facilitates the investigation of mutual interaction between multiple robustness characteristics of a schedule and the quantification of their simultaneous influence on the schedule’s operational performance. This research has contributed to fundamental new insights in the robustness of airline schedules, and a better understanding thereof, and underpins the development of future models for robust airline scheduling. The fundamental contribution of this research project was internationally recognised: it was awarded the best technical innovation at the Airline Operations Meeting of the Airline Group of the International Federation of Operational Research Societies, Denver, Colorado, 2007 and it received second place in the Anna Valicek Competition for innovative Airline Research (http://www.agifors.org/award_home.jsp).

Other ongoing ASAP projects (supported by EPSRC and Zurich and Manchester airports) are considering ways to reduce the environmental impact of other airport operations, including the movement of aircraft around the airport, the allocation of stands to aircraft and the integration of the different problems in order to get better overall results. Each of these problems is a complex on its own but the combined problem is of a completely different magnitude of complexity. Nevertheless, the experience on such problems within ASAP is enabling the development of state of the art solution methods for these problems. Meanwhile, other research (supported by EPSRC and NATS) is considering the improved utilisation of airport resources, to improve departure time predictability, and the optimisation of arrival operations, improving arrival time predictions and potentially helping to reduce delays for arriving aircraft while maintaining safety.

“The approach developed by ASAP facilitates the investigation of mutual interaction between multiple robustness characteristics of a schedule and the quantification of their simultaneous influence on the schedule’s operational performance.”
Personnel Rostering and Healthcare

Personnel Rostering

Staff rostering problems are found in a wide variety of environments. Some of the most complex and challenging problems arise in hospitals and healthcare centres, for example nurse and physician rostering. The benefits of automating the rostering process in these situations include reducing the planner’s workload and associated costs and being able to create higher quality and more flexible schedules. This has become more important recently in order to retain nurses and to attract more people into the profession. Better quality rosters also reduce fatigue and stress due to overwork and poor scheduling and help to maximise the use of leisure time by satisfying more requests. A more contented workforce leads to higher productivity, increased quality of patient service and a better level of healthcare.

Over the years, ASAP have developed world leading rostering algorithms. We have been funded by EPSRC and industrial institutions. We are currently working with SINTEF in an international collaboration in healthcare scheduling which has been funded by EPSRC, the Research Council of Norway and industry. In 2010, ASAP formed the University spin-out company Staff Roster Solutions (http://www.staffrostersolutions.com) in order to develop the commercial potential of this research. Already in 2010 the company has made a promising start having attracted commercial licensees in Europe and North America.
Radiotherapy Planning
The ASAP group has been carrying out multidisciplinary research into radiotherapy planning and scheduling for several years. The research has been funded by EPSRC. We have worked in collaboration with Coventry University, Nottingham University Hospitals NHS Trust, University Hospitals Coventry and Warwickshire NHS Trust. Our partners in NHS trusts have provided us with their expertise in the domain of radiotherapy treatment planning and scheduling of radiotherapy patients and also with real-world data that we use in our analyses and experiments.

In this field, we have investigated two major activities:

1. The generation of possible radiotherapy treatment plans for cancer patients: Case-based reasoning approaches to radiotherapy planning have been investigated. One of the main advantages of case-based reasoning is that it enables us to capture knowledge and experience of oncologists and medical physicists in radiotherapy planning. We investigate different issues that arise in the treatment of two cancer sites: (a) prostate cancer, (2) brain tumour and head and neck cancer. The main issue in prostate cancer treatment is the determination of radiation doses that are to be administered in two phases. We have developed a system for dose recommendation. The treatment of brain, head and neck cancer addresses different issues compared to prostate cancer. The dose to be delivered is usually the same for all patients, but a variety of parameters has to be determined such as the number of beams, the angles between the beams, the wedges that are used to control the distribution of radiation.

2. The scheduling of radiotherapy patients: We have develop models and algorithms for the whole process of radiotherapy planning, which includes the scheduling of a variety of resources such as the mould room, CT scanner, simulator, linear accelerators (linacs) which deliver radiation and doctors. These models consider real-world parameters and constraints, such as different categories of patients, different pathways for different sites of cancers, required type of radiation for each patient and the required number of sessions on linacs. The developed systems have enabled us to investigate the effect of an increase in patient intake and increased number of linacs on the performance of schedule.

A case-based reasoning system for prostate cancer treatment
Outreach

The ASAP research group has maintained a very successful outreach strategy, allowing us to connect our multi-disciplinary research work to the efforts of other researchers, academic institutions and industry.

**Commercialisation and Knowledge Transfer.** ASAP has been very successful in applying our research to tackle real-world problems in industry. In addition to many of our projects having industrial partners, our research is commercialised and transferred through spin out companies and knowledge transfer partnerships (KTP). We also apply our expertise to real-world problems through KTP projects, which are partnerships between businesses and academic institutions. ASAP is involved in two KTP projects each with a 2-year duration. One KTP is a partnership with Midland HR Ltd, a company that provides human Resource management software and services to a wide range of organisations. The aim of this KTP is to develop next generation rostering software using advanced scheduling techniques. The other KTP is a partnership with 3t Logistics Ltd, a company that provides logistics and transport management services to manufacturing and distribution companies. The aim of this KTP is to design, develop and implement modern heuristic algorithms for improved, adaptive carrier management and strategic scheduling.

**Postgraduate Training.** ASAP is a member of the National Taught Course Centre in Operational Research (NATCOR) funded by EPSRC (Ref. No. EP/E502067/1). It involves six leading universities in the field of Operational Research to develop and deliver taught courses to Operational Research PhD students in the UK, aiming to deepen and broaden their studies. ASAP is responsible for delivering the residential course at the University of Nottingham entitled Heuristics and Approximation Algorithms. The course is delivered over a two year cycle; the previous ones took place in 2008 and 2010. This course features the main techniques and also practical sessions, so that participants leave with the capabilities to start implementing their own heuristics.
ASAP has established and has been successfully running two biennial international conferences:

**Practice and Theory of Automated Timetabling – PATAT**
(see [www.asap.cs.nott.ac.uk/patat/patat-index.shtml](http://www.asap.cs.nott.ac.uk/patat/patat-index.shtml)) started in earlier in 1995. The previous conference took place at Queen’s University Belfast, Northern Ireland, in 2010. The conference serves as a forum for an international community of researchers, practitioners and vendors on all aspects of computer-aided timetable generation.

**Multidisciplinary International Scheduling Conference: Theory & Applications – MISTA**
(see [www.mistaconference.org](http://www.mistaconference.org)) started in 2003. The conferences have taken place in Nottingham (2003), New York (2005), Paris (2007), Dublin (2009) and the following one was held in Arizona in 2011 (August 9–12). The conference usually attracts about 120 delegates including leading scheduling researchers from around the world.

**The Conference of the UK Operational Research Society**

**OR53** (see [http://www.theorsociety.com/Pages/Conferences/OR53/OR53.aspx](http://www.theorsociety.com/Pages/Conferences/OR53/OR53.aspx)) ASAP chaired the OR53 conference of the UK Operational Research Society, September 6–8, 2011. This conference was held at the East Midlands Conference Centre in Nottingham. OR53 had an impressive list of thirty one parallel streams offering a wide variety of interest on many topics.

**YoungOR 17** (see [http://www.theorsociety.com/Pages/Conferences/YOR17/YOR17.aspx](http://www.theorsociety.com/Pages/Conferences/YOR17/YOR17.aspx)) ASAP was involved in the programme and stream-coordination of YoungOR 17, conference of the UK Operational Research Society intended for academics and practitioners within the first 10 years of their careers in OR. The conference took place at the University of Nottingham, 5-7 April 2011.
Spin Out Companies

**Aptia Solutions** (see [www.aptiasolutions.com](http://www.aptiasolutions.com)) is a software development company that spun-out from the University of Nottingham in 2004 to provide powerful yet easy to use automated nesting solutions to industries where CNC machining is an important part of the manufacturing lifecycle. In 2010/2011, Aptia added new partners to its reseller network and has secured new customers for its flagship product, AptiaNest, in construction, aerospace, and formula one racing. Several new products have also been developed to target new customer demographics: MyNesting.com – a pay per use nesting service for small businesses and hobbyists, Nestimator – for more accurate costing at the quotation stage for print and signage, and a projector system to aid ‘picking’ (removing parts from the cutting table) for aerospace manufacturers who require greater cutting throughput. At time of writing, there are over 1,400 customers worldwide using Aptia’s products to maximise material utilisation and cut out waste. The powerful cutting and packing algorithms developed by ASAP researchers are at the heart of Aptia’s products.

**EventMAP** (see [www.eventmap-uk.com](http://www.eventmap-uk.com)) is a joint venture between the University of Nottingham and Queen’s University Belfast. As an innovative example of fusion between research and practice, EventMAP specialises in institutional strategic resource and event management planning via hands-on consultancy services that generate highly flexible, user centric-solutions and a range of innovative software products. The software is based around their state-of-the-art Optime Scheduling Engine and at the heart of EventMAP’s solution provision is the integration of leading edge research based scheduling techniques which have the capability of providing significant institutional cost savings through more efficient and more satisfactory use of resource. Through the development of an innovative partnering business model, staff at EventMAP has implemented solutions in Europe, New Zealand, Australia, America, Middle East, Asia and China. The company has also taken a leading role in helping to organise the second International Timetabling Competition and the eighth PATAT conference in Belfast in 2010.

**Staff Roster Solutions** (see [www.staffrostersolutions.com](http://www.staffrostersolutions.com)) is a spin-out company formed to licence, develop and support a rostering engine which uses state-of-the-art algorithms to automatically generate optimal staff rosters. Prior to the formation of the company, the algorithms and solvers at the core of the engine were researched and developed over a number of years within ASAP. As such, the company continues to maintain close links with ASAP in order to benefit from any new advances in scheduling and optimisation theory. Although the company was only recently formed in 2010, the engine is already licensed and used by organisations in Europe and North America to create optimal rosters and work schedules.
Professional Activities

EPSRC Peer Review College
J. Bacardit, A. Bargiela, E. K. Burke, G. Kendall, N. Krasnogor, J.D. Landa-Silva, S. Petrovic

Company Directorships

E. K. Burke:
- Non-executive Director of EventMAP Ltd.
- Director of Aptia Solutions Ltd.
- Director of Staff Roster Solutions Ltd.

G. Kendall:
- Non-executive Director of EventMAP Ltd.
- Director of Aptia Solutions Ltd.
- Director of MyRIAD Solutions

Fellowships

E. K. Burke:
- Fellow of the British Computer Society
- Fellow of the Operational Research Society

G. Kendall:
- Fellow of the Operational Research Society

S. Petrovic:
- Fellow of the Institute of Mathematics and its Applications

National and International Committee Memberships

A. Bargiela:
- President of the European Council for Modelling and Simulation (Management Board Member)

E. K. Burke:
- Advisory Board of the EPSRC IDEAS Factory Network on Productivity
- Advisory Board of the EPSRC SEBASE (Software Engineering By Automated SEarch) Initiative
- Executive Committee of the EPSRC National Training Centre for Operational Research
- International Advisory Board of the BBSRC/EPSRC Centre for Plant Integrative Biology
- Scientific Steering Committee of the Isaac Newton Institute for Mathematical Sciences (nominated by EPSRC)
- Scientific Committee of the Smith Institute for Industrial Mathematics and System Engineering
- European Science Foundation (ESF) Pool of Reviewers
- UK Computing Research Committee (UKCRC)
- General Council of the OR Society
- Education and Research Committee of the OR Society
- Management Board of the EPSRC LANCS Initiative (Chairman)
- Executive Committee of the EPSRC LANCS Initiative (Chairman)
- Advisory Board of the First Cross-domain Heuristic Search Challenge
Professional Activities

S.Y. Chong:
• Awards Subcommittee of the IEEE Computational Intelligence Society Outstanding PhD Dissertation, 2009-2011

M. Hyde:
• Organising Committee of the First Cross-domain Heuristic Search Challenge (Co-chair)

G. Kendall:
• Advisory Board of the First Cross-domain Heuristic Search Challenge
• Steering Committee of the International Conference on Machine Learning and Applications, 2010
• Steering Committee of the International Conference on Machine Learning and Applications, 2009

G. Ochoa:
• Management Board of the Next Generation Decision Support: Automating the Heuristic Design Process
• Organising Committee of the First Cross-domain Heuristic Search Challenge (Co-chair)

E. Özcan:
• Executive Committee of the EPSRC LANCS Initiative
• Advisory Board of the First Cross-domain Heuristic Search Challenge
• Organising Committee of the ROADEF/EURO Challenge, 2010

A.J. Parkes:
• Executive Committee of the EPSRC LANCS initiative
• Advisory Board of the First Cross-domain Heuristic Search Challenge

S. Petrovic:
• Executive Committee of the EPSRC LANCS initiative
• EURO (European Association of Operational Research Societies) Working group on Automated Timetabling – WATT (Coordinator).
• Executive Committee of the EPSRC National Training Centre for Operational Research (NATCOR)
• Advisory Board of the First Cross-domain Heuristic Search Challenge

R. Qu:
• International Advisory Board of the Third Conference on Data Mining and Optimization (DMO’09), Universiti Kebangsaan, Malaysia, 2009
• Task Committee on Intelligent Systems Applications at IEEE Computational Intelligence Society (Member)
• Task Force on Evolutionary Scheduling and Timetabling of Evolutionary Computation Technical Committee (ECTC), IEEE Computational Intelligence Society (Chair)

Journal Editorships

J. Bacardit:
• Editorial Board of the International Journal of Applied Metaheuristic Computing
• Guest Co-editor of the special issue of the Memetic Computing journal on ‘Metaheuristics for Large-Scale Data Mining’, 2010

A. Bargiela:
• Associate Editor of IEEE Transactions on Systems, Man and Cybernetics, Part A
• Editor-in-chief of Modelling and Simulation in Engineering, Hindawi Press
• Associate Editor of Editorial Board of Information Sciences
• Editorial Board of the International Journal of Intelligent Decision Technologies (Member)
• Editorial Board of Journal of Advanced Computational Intelligence and Intelligent Informatics (Member)
• Editorial Board of the International Journal of Knowledge Engineering Systems (Member)
• Editorial Board of the International Journal of Simulation: Systems, Science & Technology (Member)

E. K. Burke:
• Editor-in-Chief of the Journal of Scheduling
• Area Editor (for Combinatorial Optimisation) of the Journal of Heuristics
• Associate Editor of the INFORMS Journal on Computing
• Associate Editor of the IEEE Transactions on Evolutionary Computation
• Editorial Board of Memetic Computing (Member)
• Guest Co-editor of a special issue of the Journal of the Operational Research Society on ‘Systems to Build Systems’, 2010
S.Y. Chong:
- Associate Editor of the IEEE Transactions on Computational Intelligence and AI in Games.

G. Kendall:
- Associate Editor of the Journal of the Operational Research Society
- Associate Editor of IEEE Transactions on Evolutionary Computation
- Associate Editor of IEEE Transactions on Computational Intelligence and Artificial Intelligence in Games
- Associate Editor of Computational Intelligence
- Associate Editor of the International Journal of Systems Science
- Associate Editor of Intelligent Systems in Accounting Finance and Management
- Associate Editor of INFOR: Information Systems and Operational Research
- Associate Editor of Cognitive Neurodynamics
- Associate Editor of International Journal of Intelligent Computing and Cybernetics

N. Krasnogor:
- Founding Editor-in-Chief (technical) for the Memetic Computing Journal, Springer
- Associate Editor of Evolutionary Computation, MIT
- Editor for Current Opinion in Biotechnology, Elsevier

D. Landa-Silva:
- Editorial Board for the Memetic Computing Journal (Member)

P.K. Lehre:
- Editorial Board for the Evolutionary Computation, MIT Press
- Guest Co-editor of the special issue of the Theoretical Computer Science on ‘Theoretical Foundations of Evolutionary Computation’, 2011

J. Li:
- Editorial Board for the Wireless Sensor Network (Member)

G. Ochoa:
- Associate Editor of Evolutionary Computation, MIT Press
- Guest Co-editor of the special issue of the Evolutionary Computation Journal on ‘Automated Design and Assessment of Heuristic Search Methods’, 2011
- Guest Co-editor of the special issue of the Journal of Heuristics on ‘Hyper-heuristics in Search and Optimisation’, 2010

E. Özcan:
- Associate Editor of the International Journal of Applied Metaheuristic Computing
- Guest Co-editor of the special issue of the Journal of Heuristics on ‘Hyper-heuristics in Search and Optimisation’, 2010

S. Petrovic:
- Associate Editor in the IMA Journal of Management Mathematics, Oxford University Press
- Editorial Board of the Yugoslav Journal of Operations Research - YUJOR (Member)

R. Qu:
- Guest Co-editor of the special issue of the IEEE Transactions on Evolutionary Computation on ‘Evolutionary Computation in Scheduling’, 2011
- Guest Co-editor of the special issue of the Journal of Scheduling on ‘Artificial Intelligence Planning and Scheduling’, 2009
Professional Activities

Chairing of Conferences

J. Bacardit:
- Workshops Chair of the Genetic and Evolutionary Computation Conference (GECCO), Portland, Oregon, 2010

A. Bargiela:
- Chair of the European Conference on Modeling and Simulation (ECMS 2010), Kuala Lumpur, June 2010
- Chair of the European Conference on Modeling and Simulation (ECMS 2009), Madrid, Spain, June 2010

E. K. Burke:
- Co-chair of the Programme Committee of the 8th international conference on the Practice and Theory of Automated Timetabling (PATAT’10), Belfast, August 2010

G. Kendall:
- Plenary Session Co-chair for the IEEE Congress on Evolutionary Computation (CEC), New Orleans, 2011.
- Co-chair of the 3rd Conference on Data Mining and Optimization (DMO), Bangi, Malaysia, 2011.
- Co-chair of the 4th Multidisciplinary International Conference on Scheduling : Theory and Applications (MISTA) conference, Dublin, Ireland, 2009

N. Krasnogor:
- Co-chair of the 2nd European Conference on Synthetic Biology, Sant Feliu de Guixols (Costa Brava), Spain, 2009.

E. Özcan:
- Joint programme scheduler and stream co-ordinator for the YoungOR conference, Nottingham, UK, 2011.

A. J. Parkes:
- Joint programme scheduler and stream co-ordinator for the YoungOR conference, Nottingham, UK, 2011.

S. Petrovic:
- Chair of the UK Operational Research Society (ORS3) conference, Nottingham, UK, 2011.

R. Qu:
- Co-chair of the IEEE Symposium on Computational Intelligence in Scheduling (CI-Sched 2009), Nashville, TN, USA, 2009

Conference Programme Committee Memberships (2009–2011)

<table>
<thead>
<tr>
<th>Name</th>
<th>Membership Period</th>
</tr>
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<tbody>
<tr>
<td>J. Bacardit</td>
<td>18 (2009-10)</td>
</tr>
<tr>
<td>R. Bai</td>
<td>5</td>
</tr>
<tr>
<td>A. Bargiela</td>
<td>12 (2009-10)</td>
</tr>
<tr>
<td>E. K. Burke</td>
<td>14 (2009-10)</td>
</tr>
<tr>
<td>S. Y. Chong</td>
<td>6</td>
</tr>
<tr>
<td>M. Hyde</td>
<td>8</td>
</tr>
<tr>
<td>G. Kendall</td>
<td>50</td>
</tr>
<tr>
<td>N. Krasnogor</td>
<td>23 (2009-10)</td>
</tr>
<tr>
<td>D. Landa-Silva</td>
<td>30</td>
</tr>
<tr>
<td>P.K. Lehre</td>
<td>9</td>
</tr>
<tr>
<td>J. Li</td>
<td>5</td>
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<td>G. Ochoa</td>
<td>8</td>
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<tr>
<td>E. Özcan</td>
<td>23</td>
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<tr>
<td>A. J. Parkes</td>
<td>4</td>
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<tr>
<td>S. Petrovic</td>
<td>15</td>
</tr>
<tr>
<td>R. Qu</td>
<td>26</td>
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</tbody>
</table>
Honours and Awards

J. Bacardit:

A. Bargiela:
- Medal of Merit for his achievements in Computational Intelligence and academic collaboration, Silesian University of Technology, Poland, 2009.
- Titular Professor, conferred by the President of Poland, 2009.

Y. Bykov:
- Winner of the International Optimisation Competition which was arranged by SolveIT Software Pty Ltd., 2011. His approach, namely Late Acceptance Hill-Climbing algorithm solved the constrained version of 2,600 x 2,600 magic square within a minute.

S.Y. Chong:

N. Krasnogor:
- Gold medal prize at the 2010 HUMIES, 2010.
- The 2010 ACM’s Special Interest Group on Evolutionary Computation Impact Award for the most highly cited paper of those published in a GECCO proceeding 10 years earlier.

P.K. Lehre:

E. Özcan:

A. J. Parkes:
Publications (2009-2011)

**Books**

2010


2009


**Book Chapters**

2011


2010


2009


PhD Theses

2011


2010


2009
J. Baxter. *Collaborative Decision Making in Uncertain Environments*, PhD Dissertation, the University of Nottingham, April 2009.


**Journal Papers**

2011


2010


2009


**Journal Papers in Press**


R. Bai, J. Blazewicz, E. K. Burke, G. Kendall, and B. McCollum. A simulated annealing hyper-heuristic methodology for flexible decision support. *Accepted for publication in 4OR*.

R. Bai, G. Kendall, R. Qu, and J. Atkin. Tabu assisted guided local search approaches for freight service network design. *Accepted for publication in Information Sciences*.


E.K. Burke, T. Curtois, R. Qu, and G. Vanden Berghe. A time pre-defined variable depth search for nurse rostering. *Accepted for publication in INFORMS Journal on Computing*.


E. K. Burke, M. Hyde, G. Kendall, and J. Woodward. Grammatical evolution of local search heuristics. *Accepted for publication in IEEE Transactions on Evolutionary Computation*.

E. K. Burke and M. R. Hyde, and G. Kendall A squeaky wheel optimisation methodology for two dimensional strip packing. *Accepted for publication in Computers & Operations Research*.

E. K. Burke, M. Hyde, and G. Kendall. Automating the packing heuristic design process with genetic programming. *Accepted for publication in Evolutionary Computation*.


E.K. Burke, N. Pham, R. Qu, J. Yellen. Linear combinations of heuristics for examination timetabling. *Accepted for publication in Annals of Operations Research*.

P.K. Lehre and X. Yao. Runtime analysis of the (1+1) EA on computing unique input output sequences. Accepted for publication in Information Sciences.

J. Li, E. K. Burke, and R. Qu. A pattern recognition based intelligent search method: two case studies on the assignment problem. Accepted for publication in Applied Intelligence.

J. Li, P. Hingston, and G. Kendall. Engineering design of strategies for winning iterated prisoner's dilemma competitions. Accepted for publication in IEEE Transactions on Computational Intelligence and AI in Games.


N. Mishra, S. Petrovic, and S. Sundar. A self-adaptive case-based reasoning system for dose planning in prostate cancer. Accepted for publication in Medical Physics.

P. Moratori, S. Petrovic, and A. Vázquez-Rodríguez. Integrating rush orders into existent schedules for a complex job shop. Accepted for publication in Applied Intelligence.


R. Qu, Y. Xu, J. Castro, and D. Landa-Silva. Particle swarm optimization for the steiner tree in graph and delay-constrained multicast routing problems. Accepted for publication in Journal of Heuristics.


N.R. Sabar, M. Ayob, G. Kendall, and R. Qu. A graph coloring constructive hyper-heuristic for examination timetabling problems. Accepted for publication in Applied Intelligence.


H. Xing and R. Qu. A compact genetic algorithm for the network coding based resource minimization problem. Accepted for publication in Applied Intelligence.

Y. Xu and R. Qu. A hybrid scatter search meta-heuristic for delay-constrained multicast routing problems. Accepted for publication in Applied Intelligence.

Y. Xu and R. Qu. An iterative local search approach based on fitness landscapes analysis for the delay-constrained multicast routing problem. Accepted for publication in Computer Communications.

Z. Zakaria and S. Petrovic. Genetic algorithms for match-up rescheduling of the flexible manufacturing systems. Accepted for publication in Computers & Industrial Engineering.

Please refer to the main ASAP web page for a full list of publications: http://www.asap.cs.nott.ac.uk/
<table>
<thead>
<tr>
<th>Title</th>
<th>Principal Investigator (Lead Scientist)</th>
<th>Co-Investigator(s)</th>
<th>Collaborator(s)</th>
<th>Funding Body</th>
<th>Dates</th>
<th>Total Amount</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection and Prediction of Lung Cancer using the zNose with the Support Vector Machine classifier</td>
<td>Arelhi Bargiela, Isa, Ting</td>
<td>MOSTI (01-02-12-SF0089)</td>
<td>Ningbo Municipal Science and Technology Bureau, China</td>
<td>£185,000</td>
<td>1/12/2009 to 31/05/2011</td>
<td>£39,360 Collaborative project with EEE-UNMC</td>
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<tr>
<td>Handling Uncertainties in Transportation and Logistics using Granular Computing and Hyper-heuristics</td>
<td>Bai Qu, Burke, Bargiela</td>
<td>Ningbo Municipal Natural Science Foundation, China</td>
<td>Ningbo University</td>
<td>£10,000</td>
<td>11/9/2008 to 31/12/2011</td>
<td>£39,360 This is a project awarded to the University of Nottingham Ningbo, China, funded by China Ningbo Municipal Natural Science Foundation</td>
<td></td>
</tr>
<tr>
<td>An investigation of the robustness of transportation scheduling for modern logistics.</td>
<td>Bai, Anberree</td>
<td>Ningbo Municipal Natural Science Foundation, China</td>
<td>Ningbo University</td>
<td>50,000 RMB</td>
<td>1/2/2008 to 28/2/2010</td>
<td>£4,500 This is a project awarded to the University of Nottingham Ningbo, China, funded by China Ningbo Municipal Natural Science Foundation</td>
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<tr>
<td>Dynamic Scheduling and Hyper-Heuristic Approaches for Logistics Service Network Design and Fleet Scheduling</td>
<td>Bai, Kendall, Qu</td>
<td>Zhejiang Provinical Natural Science Foundation (ZJNSF)</td>
<td>Zhejiang University</td>
<td>£100,000 RMB</td>
<td>1/6/2010 to 31/5/2013</td>
<td>£9,458 This is a renewal of our platform grant</td>
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<tr>
<td>Towards More Effective Computational Search</td>
<td>Burke, Akin</td>
<td>EPSRC through the Smith Institute for Industrial Mathematics and System Engineering</td>
<td>NATS (£24,000)</td>
<td>£84,000</td>
<td>1/9/2009 to 31/05/2013</td>
<td>£101,458 EPSRC First Grant scheme</td>
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<td>Hybridising Exact and Heuristic Search Methods for Landing Operations at London Heathrow</td>
<td>Burke, Akin</td>
<td>ESRC (EPSRC)</td>
<td>EPSRC (£100,000)</td>
<td>£60,000</td>
<td>1/6/2010 to 31/8/2011</td>
<td>£22,800 This project is a CASE studentship which is being supported by National Air Traffic Services Ltd.</td>
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<tr>
<td>An investigation of the robustness of transportation scheduling for modern logistics.</td>
<td>Burke, Akin</td>
<td>ESRC (£100,000)</td>
<td>EPSRC (£100,000)</td>
<td>£25,232</td>
<td>1/04/2009 to 31/05/2013</td>
<td>£561,924 This EPSRC grant was awarded during an EPSRC sandpit event in November 2008. It represents a major collaboration between Manchester Airport, Zurich Airport, Loughborough and Liverpool Airport and the Universities of Nottingham, Salford, Loughborough and Liverpool.</td>
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<tr>
<td>Title</td>
<td>Principal Investigator(s)</td>
<td>Co-Investigator(s)</td>
<td>Funding Body</td>
<td>Total Amount</td>
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<td>Enhanced Airport Collaborative Decision Making by Integrating Passenger and Baggage Operations</td>
<td>Burke</td>
<td>Atkin</td>
<td>NATS</td>
<td>£27,000</td>
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<td>Investigating Automated Methodologies to Generate the Target Start-up Approval Time at London Heathrow</td>
<td>Burke</td>
<td>Landi, Silva, Petrovic, Garibaldi, Kendall, Krarner, Qu</td>
<td>Research Council of Norway</td>
<td>£63,485</td>
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<td>Optimisation Methods in Health Care Planning</td>
<td>Burke</td>
<td>Landi, Silva, Petrovic, Garibaldi, Kendall, Krarner, Qu</td>
<td>Research Council of Norway</td>
<td>£63,485</td>
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<td>PLATFORM: Towards More General Optimisation/Search Systems</td>
<td>Burke</td>
<td>Kendall, Garibaldi, Petrovic, Krarner, Qu</td>
<td>EPSRC (GR/S70197/01)</td>
<td>£422,908</td>
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<td>Adaptive Multi-Objective Heuristic and Meta-heuristic Approaches to Space Allocation</td>
<td>Burke</td>
<td>Kendall, Landi, Silva</td>
<td>EPSRC (GR/S865328)</td>
<td>£21,240</td>
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<tr>
<td>Next Generation Decision Support: Automating the Heuristic Design Process</td>
<td>Burke</td>
<td>Garibaldi, Petrovic, Garibaldi, Kendall, Krarner, Qu</td>
<td>EPSRC (GR/T23374/01)</td>
<td>£21,240</td>
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<tr>
<td>Investigating Automated Methodologies to Generate the Target Start-up Approval Time at London Heathrow</td>
<td>Burke</td>
<td>Landi, Silva, Petrovic, Garibaldi, Kendall, Krarner, Qu</td>
<td>EPSRC (GR/T26115/01)</td>
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<td>Adaptive Multi-Objective Heuristic and Meta-heuristic Approaches to Space Allocation</td>
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<td>Kendall, Landi, Silva</td>
<td>EPSRC (GR/T23374/01)</td>
<td>£21,240</td>
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<tr>
<td>TOWARDS A FRAMEWORK FOR MODELLING VARIATION IN AUTOMATED DECISION SUPPORT</td>
<td>Bieter</td>
<td>Burke, Kendall, Garibaldi, Krasnogor, Qu</td>
<td>EPSRC (EP/G850938/1)</td>
<td>£143,828</td>
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<tr>
<td>Models and Algorithms for Complex Scheduling Problems: Visiting Fellowship</td>
<td>Bieter</td>
<td>Garibaldi, Krasnogor, Qu</td>
<td>EPSRC (EP/G850938/1)</td>
<td>£143,828</td>
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<td>BIOPTRAIN: Research Training Network for Bioinformatics/Optimisation</td>
<td>Bieter</td>
<td>Garibaldi, Krasnogor, Qu</td>
<td>EPSRC (EP/G850938/1)</td>
<td>£143,828</td>
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<tr>
<td>Towards a Framework for Modelling Variation in Hyper-heuristics for Scheduling, Rostering and Routing</td>
<td>Bieter</td>
<td>Garibaldi, Krasnogor, Qu</td>
<td>EPSRC (EP/G850938/1)</td>
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<td>Models and Algorithms for Complex Scheduling Problems: Visiting Fellowship</td>
<td>Bieter</td>
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<tr>
<td>Title</td>
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<td>Co-Investigator(s)</td>
<td>Funding Body</td>
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<td>A National Taught Course Centre in Operational Research (NATCOR)</td>
<td>Glazebro</td>
<td>Burke</td>
<td>EPSRC (EP/ES02067/1) £241,052</td>
<td></td>
<td>1/10/2006 to 30/9/2011</td>
<td>£241,052</td>
<td>This is a UK-wide initiative to provide a high level of taught course PhD provision. It involves Lancaster, Nottingham, Southampton, Cardiff, Brunel and Warwick</td>
</tr>
<tr>
<td>Centre for Plant Integrative Biology: Novel Modelling Paradigms</td>
<td>Hodgman</td>
<td>Krasnogor</td>
<td>BBSRC (BB/D0196T3/1) £500,768</td>
<td></td>
<td>1/2/2007 to 31/1/2012</td>
<td>£500,768</td>
<td>This is part of the £9.2M Centre for Plant Integrative Biology</td>
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<tr>
<td>Monitoring and Prediction of Blood Sugar level for Diabetics through the use of intelligent software</td>
<td>Isa</td>
<td>Bargiela, Arelli, Ting</td>
<td>MOSTI (01-02-12-SF0056) RM126,000</td>
<td>Dept for Env Food and Rural Aff</td>
<td>1/05/2010 to 30/11/2011</td>
<td>£26,800</td>
<td>Collaborative project with EEE-UNMC</td>
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<tr>
<td>EP/E017975/1: An Investigation of Regulatory Decision Making by Automated Decision Makers</td>
<td>Kendall</td>
<td>Pollard, Soane</td>
<td>EPSRC (EP/E017975/1) £222,411</td>
<td>Dept for Env Food and Rural Aff</td>
<td>1/10/2006 to 31/10/2009</td>
<td>£222,411</td>
<td>This is an EPSRC Ideas Factory</td>
</tr>
<tr>
<td>EP/D031079/1: NETWORK: Interdisciplinary Cutting, Packing and Space Allocation</td>
<td>Kendall</td>
<td>Burke</td>
<td>EPSRC</td>
<td>Aptia Solutions Ltd, Gower Optimal Algorithms Ltd, JoTiKa (Midlands) Software Ltd, Real Time Solutions Ltd, SigmaTEK Europe Ltd</td>
<td>1/3/2006 to 28/02/2009</td>
<td>£63,212</td>
<td>This is an EPSRC NETWORK</td>
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<tr>
<td>An Investigation of Collaborative Robotics</td>
<td>Kendall</td>
<td></td>
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<td>1/3/2006 to 28/2/2009</td>
<td>£20,965</td>
<td>This project provides industrial support for a University of Nottingham funded CASE studentship</td>
</tr>
<tr>
<td>Bioinformatics, Systems and Synthetic Biology Plant Science Summer School</td>
<td>Krasnogor</td>
<td>Bacardit, Bennett (Biosciences)</td>
<td>European Science Foundation (ESF-2482) £60,435</td>
<td></td>
<td>18/3/2009 to 31/9/2009</td>
<td>£51,756</td>
<td>This covers the lodging and travel expenses of the 50 participants of an International Summer School.</td>
</tr>
<tr>
<td>(Semi) Formal Artificial Life Through P-systems &amp; Learning Classifier Systems: An Investigation into InfoBiotics</td>
<td>Krasnogor</td>
<td></td>
<td>EPSRC (EP/E017215/1) £515,565</td>
<td>Centre For Biomolecular Sciences, UoN</td>
<td>1/9/2007 to 31/8/2010</td>
<td>£515,565</td>
<td>This project investigates a new (semi) formal cellular Artificial Life methodology, which is called as InfoBiotics</td>
</tr>
<tr>
<td>The Logistics of Small Things: a crossdisciplinary feasibility account</td>
<td>Krasnogor</td>
<td>Prof. M. Camara, Prof. E. K. Burke</td>
<td>EPSRC (EP/H024905/1) £202,805</td>
<td>Centre For Biomolecular</td>
<td>1/11/2009 to 30/4/2012</td>
<td>£202,805</td>
<td>This project investigates accelerating nanoscience, smart drugs automated programming, and optimising the life-cycle of synthetic biology projects</td>
</tr>
<tr>
<td>Evolutionary Optimisation of Self Assembling Nano-Designs (ExStENCe)</td>
<td>Krasnogor</td>
<td>Prof. P. Beton, Prof. P. Moriarty, Prof. N. Champness</td>
<td>EPSRC (EP/H010432/1) £945,423</td>
<td>Physics &amp; Astronomy, UoN</td>
<td>1/2/2010 to 31/1/2013</td>
<td>£945,423</td>
<td>This proposal aims the development of novel evolutionary algorithms (EAs) and protocols, based on deeper principles than currently available, for the optimisation, design and exploitation of molecular self-assembly.</td>
</tr>
<tr>
<td>SynBioNT: A Synthetic Biology Network for Modelling and Programming Cell-Chell Interactions</td>
<td>Krasnogor</td>
<td>Prof. C. Alexander</td>
<td>BBSRC (BB/F01855X/1)</td>
<td>Pharmacy, UoN</td>
<td>1/5/2008 to 30/4/2011</td>
<td>£74,587</td>
<td>This network is funded by BBSRC (BB/F01855X/1) with co-funding from EPSRC and ESRC.</td>
</tr>
<tr>
<td>Plan, Develop and Implement a Telematics Based Predictive Maintenance System for Commercial Vehicles</td>
<td>Landa Silva</td>
<td>Kendall</td>
<td>Technology Strategy Board</td>
<td>Microlise Ltd</td>
<td>1/11/2011 to 31/10/2013</td>
<td>£164,234</td>
<td>This project is a Knowledge Transfer Partnership (KTP No 8667)</td>
</tr>
<tr>
<td>Towards More Effective Multi-objective Meta-Heuristics to Solve Complex Combinatorial Problems</td>
<td>Landa Silva</td>
<td></td>
<td>EPSRC (EP/E019781/1) £204,877</td>
<td></td>
<td>1/1/2007 to 31/12/2009</td>
<td>£204,877</td>
<td>This is funded under EPSRC’s First Grant Scheme</td>
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<tr>
<td>Title</td>
<td>Principal Investigator / Lead Scientist</td>
<td>Co-Investigator(s)</td>
<td>Funding Body</td>
<td>Collaborator(s)</td>
<td>Dates</td>
<td>Total Amount</td>
<td>Notes</td>
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<tr>
<td>Developing Next Generation Rostering Software Using Advanced Scheduling Techniques</td>
<td>Landa Silva</td>
<td>Burke, Qu</td>
<td>Technology Strategy Board</td>
<td>Midland Software Limited</td>
<td>12/08/2008 to 15/02/2011</td>
<td>£111,992</td>
<td>This project is a Knowledge Transfer Partnership (KTP No 7074)</td>
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<tr>
<td>Design, Develop and Implement Modern Heuristic Algorithms for Improved, Adaptive Carrier, Management and Strategic Scheduling</td>
<td>Landa Silva</td>
<td>Kendall</td>
<td>Technology Strategy Board</td>
<td>3t Logistics Ltd</td>
<td>1/01/2010 to 31/12/2011</td>
<td>£124,672</td>
<td>This project is a Knowledge Transfer Partnership (KTP No 7449)</td>
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<tr>
<td>Temporal and Spatial Pattern Recognition in Dynamic Networks</td>
<td>Petrovic</td>
<td></td>
<td>EPSRC Knowledge Transfer Secondments Programme £42,027</td>
<td>EADS-UK, Newport</td>
<td>1/12/2011 to 1/09/2012</td>
<td>£111,772</td>
<td>This project has been awarded by the EPSRC Knowledge Transfer Secondments Programme which is a part of the Strategic Framework Agreement between the University of Nottingham and EPSRC</td>
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<tr>
<td>Novel Approaches to Radiotherapy Planning and Scheduling in the NHS</td>
<td>Petrovic</td>
<td>Burke, Garibaldi</td>
<td>EPSRC (EP/C549511/1) £268,315</td>
<td>Nottingham City Hospital and Walsgrave General Hospital £95,000</td>
<td>1/11/2005 to 28/2/2010</td>
<td>£363,315</td>
<td>This is a collaborative project with Coventry University</td>
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<tr>
<td>Hybrid Algorithms to Large Scale Portfolio Optimisation</td>
<td>Qu</td>
<td>Pont</td>
<td>Industrial Mathematics Internship</td>
<td></td>
<td>1/1/2010 to 5/1/2010</td>
<td>£8,130</td>
<td>This internship project is a collaborative project with NAG, Oxford to model and solve the complex large scale portfolio optimisation problems.</td>
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<tr>
<td>CHELLnet: A Unifying Investigation in Artificial Cellularity and Complexity</td>
<td>Whitaker</td>
<td>Krasnogor</td>
<td>EPSRC (EP/D023343/1) £81,737</td>
<td></td>
<td>1/10/2005 to 31/3/2009</td>
<td>£81,737</td>
<td>This is an IDEAS Factory project collaborating with the Universities of Edinburgh, Glasgow, Imperial College London, Leeds, Manchester, Oxford and Southampton</td>
</tr>
</tbody>
</table>

**ASAP Funds by Source**  
(Grants held during 2009-2011)
# ASAP Personnel

## Academic Staff

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Contact Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanja Petrovic</td>
<td>Head of Group</td>
<td>(0115) 95 14222  <a href="mailto:sxp@cs.nott.ac.uk">sxp@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~sxp/">www.cs.nott.ac.uk/~sxp/</a></td>
</tr>
<tr>
<td>Jason Atkin</td>
<td>Science and Innovation Lecturer</td>
<td>(0115) 95 14206  <a href="mailto:ekb@cs.nott.ac.uk">ekb@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~jaa/">www.cs.nott.ac.uk/~jaa/</a></td>
</tr>
<tr>
<td>Dario Landa-Silva</td>
<td>Lecturer</td>
<td>(0115) 84 66522  <a href="mailto:jds@cs.nott.ac.uk">jds@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~jds/">www.cs.nott.ac.uk/~jds/</a></td>
</tr>
<tr>
<td>Per Kristian Lehre</td>
<td>Science and Innovation Lecturer</td>
<td>(0115) 82 32823  <a href="mailto:pkl@cs.nott.ac.uk">pkl@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~pkl/">www.cs.nott.ac.uk/~pkl/</a></td>
</tr>
<tr>
<td>Ender Özcan</td>
<td>Science and Innovation Lecturer</td>
<td>(0115) 95 15544  <a href="mailto:exo@cs.nott.ac.uk">exo@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~exo/">www.cs.nott.ac.uk/~exo/</a></td>
</tr>
<tr>
<td>Andrew Parkes</td>
<td>Science and Innovation Lecturer</td>
<td>(0115) 95 14210  <a href="mailto:ajp@cs.nott.ac.uk">ajp@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~ajp/">www.cs.nott.ac.uk/~ajp/</a></td>
</tr>
<tr>
<td>Rong Qu</td>
<td>Lecturer</td>
<td>(0115) 84 66503  <a href="mailto:rxq@cs.nott.ac.uk">rxq@cs.nott.ac.uk</a>  <a href="http://www.cs.nott.ac.uk/~rxq/">www.cs.nott.ac.uk/~rxq/</a></td>
</tr>
</tbody>
</table>
China Campus

Rubin Bai
Associate Professor
Ningbo Campus, China
+86 (0) 574 8818 0278
rzb@cs.nott.ac.uk
www.cs.nott.ac.uk/~rzb/

Dr Jingpeng Li
Lecturer
+86 (0) 574 8818 6435
jpl@cs.nott.ac.uk
www.cs.nott.ac.uk/~jpl/

John Woodward
Lecturer
+86 (0) 574 8818 0239
jrw@cs.nott.ac.uk
www.cs.nott.ac.uk/~jrw/

Malaysia Campus

Siang Yew Chong (UNMC)
Lecturer
Malaysia Campus
+6 (03) 8924 8148
Siang-Yew.Chong@nottingham.edu.my
baggins.nottingham.edu.my/~khczcsy/

Graham Kendall
Vice Provost for Research and Knowledge Transfer & Professor of Computer Science
+6 (03) 8924 8306
Graham.Kendall@nottingham.edu.my
http://www.graham-kendall.com/

Administrative Staff

Debbie Pitchfork
ASAP Research Group Project Manager
(0115) 84 66543
dap@cs.nott.ac.uk

Senior Research Fellows

Dr Matthew Hyde
Dr Gabriela Ochoa
Research Associates

Dr Yuri Bykov
Dr Tim Curtois
Dr Geert De Maere
Dr Jiawei Li
Dr Jerry Swan
Dr Glenn Whitwell
Dr Xia Xiaolei

PhD Students

Sam Allen
Belal Ismail Khalil Al-Khateeb
Stanislava Armstrong
Amadeo Asco
Zalilah Abd Aziz
Monica Banerjea
Elkin Castro
Juan Pedro Castro Gutierrez
Michael Clark
John Drake
Ha Duong
Anas Elhag
Enrico Glaab
Sven Groenemeyer
Qiang Guo
PhD Students

Nor Hayati Hamid
Fang He
Rob Hellier
Joe Henry Obit
Rupa Jagannathan

Mohd Nizam
Ahmed Kheiri
Khoi Le
Mashael Maashi
Jakub Marecek

Mohmad Kahar
Patrick Barbosa
Mohamed
Nam Pham

Nishikant Mishra
Abdullah
Tiago Pais

Muhammed
Moratori

Nishikant Mishra
Abdullah
Patrick Barbosa

Muhammed
Moratori

Tim Pigden
Syariza Abdul
Stefan Ravizza

Rahman

Shamsudin

Amr Soghier
Saiful Izwan
Ozgur Ulker

Suliman

Shamsudin

Huanlai Xing

MD Sarif

Ying Xu
Visiting Fellows/Associated Staff

Jacek Blazewicz  
Visiting Professor

Peter Brucker  
EPSRC Visiting Fellow

A. Şima Uyar  
Visiting Scholar

Michel Gendreau  
EPSRC Visiting Fellow

Barry McCollum  
Industrial Research Fellow

Ceyda Oguz  
Visiting Professor

Previous Members

Jaume Bacardit  
School of Computer Science Lecturer

Andrzej Bargiela  
School of Computer Science  
Professor of Computer Science (UNMC)

Edmund K. Burke  
PVC for Research,  
University of Stirling  
Previous Head of Group  
Professor of Computer Science

Natalio Krasnogor  
School of Computer Science  
Professor of Computer Science

Nick Poxon  
ASAP Research Support Coordinator

Ebru Tasci  
Administrative Assistant

Dr Robert Oates  
Research Associate

Dr Azhar Ali Shah Syed  
Research Associate

Dr Leong Ting Lui  
Research Associate

Dr German Terrazas Angulo  
Research Associate
Previous Members

Dr Jamie Twycross  
*Research Associate*

Dr Pawel Widera  
*Research Associate*

Jonathan Blakes  
*PhD Student*

Jack Chaplin  
*PhD Student*

Maria Franco  
*PhD Student*

James Smaldon  
*PhD Student*

Adam Sweetman  
*School of Physics  
PhD Student*

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