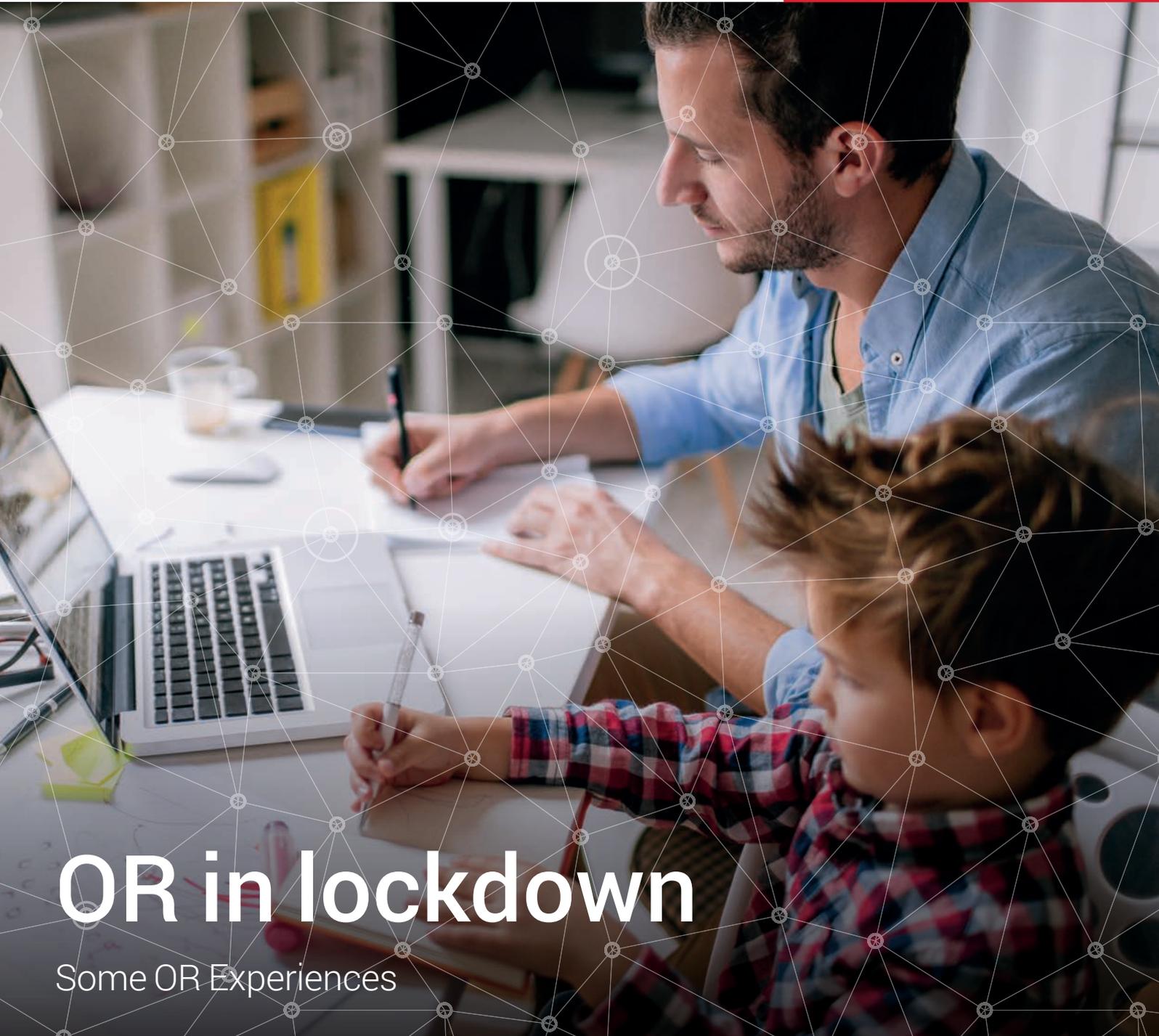


INSIDE

THE SCIENCE OF BETTER AT THE HEART OF ANALYTICS



OR in lockdown

Some OR Experiences

inside:

Communicating well

New ways of communicating with others while self-isolating at home

New blood wanted

The OR in the Third Sector (ORiTS) Special Interest Group is seeking new Committee members

Prize presentation

Doctoral award talk given at Beale lecture

DIARY DATES 2020

EVENT	DATE	VENUE
Women in OR and Analytics	4 November 2020	BMA House, London
Careers Open Day	17 November 2020	Millennium Point, Birmingham
Blackett Memorial Lecture	Date TBC, November 2021	Royal Society, London
Analytics Summit 2021	11 February 2021	IET, Savoy Place, London
SW20	22-24 March 2021	Loughborough University
38 ISMOR	20-23 July 2021	Royal Holloway, University of London
OR63 Annual Conference	Date TBC, September 2021	University of Warwick

The OR Society is following advice from the government, Public Health and the World Health Organisation in relation to COVID-19. All events and training courses until the end of July have been postponed and the rescheduled dates for ORS events in 2021 are detailed above, please check our website for the latest details or for specific enquiries contact us at event.enquiry@theorsociety.com.

OR Society Members: Are you keeping us up to date? Have you moved house or changed jobs recently? If so, please log in to your membership account at www.theorsociety.com and update your contact information. Questions about your membership or your login details? Contact our membership team at membership@theorsociety.com or **0121 233 9300**.

Submitting Articles for Inside OR

Guidelines and format:

- 1) MS Word document of 500 words.
- 2) Articles may be edited for space, grammar and accuracy.
- 3) Inside OR adheres to the University of Oxford Style Guide.
- 4) Deadline for submissions is the first of each month.

Contributions should be submitted as an MS Word document to insideor@theorsociety.com and will be edited at the discretion of the editor. Please submit print-quality, high-resolution photos or graphics attached as one of these file formats: JPEG, TIFF, PSD, EPS or AI with the articles. Print-quality resolution requires a minimum graphic size of 640 x 480px or scans made at 300dpi. Do not submit copyrighted photos, graphics or content unless you are the copyright holder or have written permission for reproduction from the copyright holder, which should be part of your submission. Photos and graphics copied from websites are almost always not suitable for printing and are usually copyrighted by someone. The editor's decision on all contributions is final and no correspondence will be entered into.

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Editorial

MAY 2020

JOHN CROCKER, FORS



As you can imagine, the predominant issues this month are, yet again, concerned with COVID-19. We take a quick look at some of the models being used to simulate the spread, some of the tools being used to help care for those suffering and how we, as operational researchers might be able to help.

I think it is probably fair to say that none of us could have predicted what has happened and is still happening. It was inevitable that one day a

new strain of virus or bacteria would cause a worldwide pandemic. Although COVID-19 will kill an enormous number of people it looks like most will survive.

Unfortunately our troubles do not end there. A very large number of small businesses and probably a number of large ones will not survive the consequences of the imposed lock-downs being applied in many countries throughout the world. Exactly what life will be like after the pandemic has passed is possibly even harder to predict. Developing models to predict how the disease will spread is relatively straightforward – there are only a small number of key variables involved (although, we are unlikely to ever know what the true values of these are). Determining which businesses will survive and which will prosper is a much more difficult problem. In addition, the money that governments are making available to support individuals and businesses whilst countries are in lock-down will have to be recovered inevitably through some form of taxation. If attempts to recover this money are made too soon or too harshly then the consequences could be even worse than those caused by the initial action. The skills of operational researchers should be in great demand.

One good that could come out of this is the realisation that a very large number of people can work from home without the need to travel to the office, to meetings or to presentations. If we could get into the habit of considering such journeys as the exception rather than the norm we could have a very major impact on reducing pollution (including “greenhouse gases”). These changes could go a long way to making us carbon neutral although it is almost certain we will still have to develop ways of removing CO₂ and possibly nitrous oxides from the atmosphere to bring global temperatures back to pre-industrial revolution levels.

In the meantime, it is good to see that life is still going on in some areas with two of our sponsored MSc students, Rebecca and Martha, reporting good progress even if they are unlikely to be able to spend any time in an industrial environment. It is also interesting to see how various members have been coping with the lock-down my thanks to Ruth for this fascinating insight.

If you have any interesting stories or pearls of wisdom that you would like to make known to the wider community, please send them in. I shall be happy to collate them.

May I also take this opportunity to thank Hilary for being such a good friend and for all of those events and conferences she has organised. We wish you a very long and happy retirement.

I don't like to end on a sad note but I know that a great many of you will be much saddened to hear of the loss of Tony Lewis – he was such a lovely man with such a friendly smile. Our condolences and thoughts are with his family. 

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Sir David Spiegelhalter

The Guy Medal in Gold 2020 has been awarded to Sir David Spiegelhalter. Guy Medals, named after William Guy, are awarded by the Royal Statistical Society (RSS) in three categories: Gold, Silver and Bronze.

The Guy Medal in Gold was awarded to Sir David Spiegelhalter who was judged to have merited a signal mark of distinction by reason of his innovative contributions to the theory or application of statistics. 

You can read more about Sir David and his Guy award at: <https://bit.ly/dspiegelhalter>

Sapience abandoned

Barclays has scrapped the use of an employee monitoring platform following a backlash from staff and criticism from privacy professionals and employment lawyers.

The platform, known as Sapience, had been described as the “most advanced and automated” people analytics solution. It supposedly allows managers to guide their teams more efficiently and allow for efficient tracking of employees’ performances and work habits.

However, a person who had first-hand experience of being subjected to it, said, “The stress this is causing is beyond belief, it shows an utter disregard for employee wellbeing”. 

More at: <https://bit.ly/barclayspeople>



Time to Rethink Globalised Supply?

The COVID-19 pandemic could be the “wake-up call” that managers need to prompt them to consider actions that will improve their resilience to future shocks.

According to Willy Shih, writing in Sloan Management Review March 2020 edition, “COVID-19 contagion had a major impact on Chinese manufacturers, and due to the central role many Chinese companies play in the supply chains of other companies today, this affects our world.” 

Just-in-time only works if the supply chain remains unbroken. Read more on this at: <https://bit.ly/WillyShih>

StarNet image classifier

IBM researchers are developing an end-to-end trainable image classifier that is able to localise what it believes to be the key regions supporting its predictions. Called StarNet, it will, in addition to addressing the task of visual classification, also support the task of weakly supervised few-shot object detection, such that only a small amount of noisy data is required to achieve reasonable accuracy with it.

StarNet could increase transparency in and reduce the amount of training data needed for new visual domains, as well as cutting down on deployment times. 

More at: <https://bit.ly/Starclassifier>



Tracking COVID-19

COVID-19 has been detected in more than 100 nations around the globe according to the WHO.

The spread of the illness has been tracked worldwide, and its impact noted by American management consulting firm McKinsey and Company.

Mark Andrejevic and Neil Selwyn, Monash University have published a paper which shows how smartphones could aid in data tracking where the handsets could be 'repurposed' as monitoring systems to support management and control of the public. 

More at: <https://bit.ly/trackingCovid-19>



Analytics is not a panacea

Gartner has identified several potential points of failure for projects aimed at understanding customers and improving performance. Specific analytical capabilities risk producing fragmented, narrowly focused analytics end-user initiatives driven by tactical opportunities rather than a broad-based optimal strategy.

The IoT requires different skills from traditional business analytics projects, and failure to establish a strategy for acquiring IoT skills will prevent organisations from using IoT data or to create the next generation of smart devices. Companies should also not try to substitute technology for training. 

More at: <https://bit.ly/Analyticspanacea>

I name that tune in...

A musician and a lawyer have used an algorithm to generate every possible melody to end music copyright lawsuit claims. Damien Riehl and Noah Rubin have created a catalogue of 68 billion 8-note melodies.

Damien Riehl says, "The copyright system is broken, and it needs updating. Under copyright law, numbers are facts, and under copyright law, facts either have thin copyright, almost no copyright, or no copyright at all. Algorithms can be used to determine what is copyright protected and what is not." 

More at: <https://bit.ly/musiccopyrights>



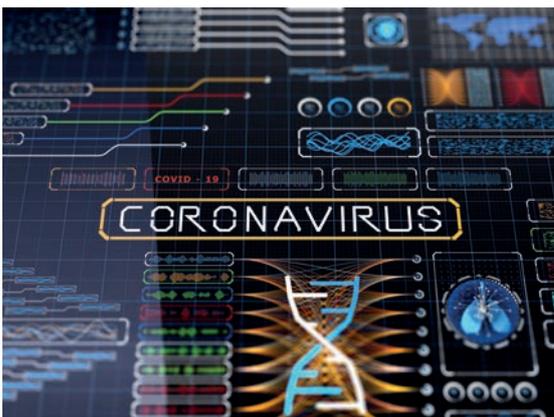
Simulating the spread of COVID-19

An article in Scientific American by Jeremy Hsu has offered some insight into how computer modelling can provide some clarity amid the confusion surrounding the outbreak.

There are three primary factors: morbidity rate; mortality rate and; reproduction number (R_0) the average number of new cases caused by an infected individual. None of these are known, however, as data becomes available we should be able to improve our estimation of each.

The best estimate for R_0 is 2-3. The mortality rate appears to be [positively] correlated with age but is also affected by underlying health conditions. 

More at: <https://bit.ly/JeremyHsu>



Can you help?

An open-access neural network called COVID-Net, developed by Linda Wang and Alexander Wong, University of Waterloo and DarwinAI in Canada has been released to help researchers develop an AI tool that can test people for COVID-19.

COVID-Net is a convolutional neural network which has been trained to identify signs of COVID-19 in chest x-rays using 5,941 images taken from 2,839 patients with various lung conditions, including some with COVID-19. The data set is being provided alongside the tool in the hope that it will encourage others to help turn it into a production ready tool. 

More at: <https://bit.ly/CovidNet>



Speech-recognition software bias

None of the five state-of-the-art automated speech-recognition (ASR) software is as good at interpreting the voices of 73 black people compared to 42 white people according to researchers at Stamford and Georgia.

Amazon, Apple, Google, IBM, and Microsoft ASRs scored an average word error rate (WER) of 0.35 for black speakers compared with 0.19 for white speakers. Apple was the worst: 0.45 versus 0.23. Microsoft was the best: 0.27 versus 0.15. 

More at: <https://bit.ly/speechsoftware>

Society stalwart retires

Long-serving staff member, Hilary Wilkes, the Society's Conference and Events manager has announced her imminent retirement. In fact, accounting for a backlog of holidays owed, Hilary already has her feet up and is enjoying her time at home. Her final official day of employment is 8 May.

Hilary has been with the Society almost 17 years, joining in October 2003. Having worked in general office management and accounts, she took an opportunity for a switch in roles in 2010 and took on the conference management role that most of you will know her for. Her contribution to the Society in the decade that she's held that post has been immense.

Her first conferences flying solo were both in Nottingham in 2011 – YOR17 and OR53 – and she's been bringing her attention to detail and highest standard of excellence to our events ever since.

Hilary guided us through our biggest conference challenge in recent years – EURO2015 – where we had approaching ten times the usual number of delegates. Her swansong would have been the Simulation Workshop (SW20) event at the end of March/start of April, but of course that has been cancelled. Present restrictions have prevented us organising a proper send-off, but we hope to do something later in the year, possibly at the Blackett lecture.

Enjoy your well-deserved retirement, Hilary. You'll be sorely missed by the staff and the whole OR community. 



Communicating well

Richard Eglese, Chair, Publications Committee



We are living in unprecedented times. I am writing this leader at the end of March and over the past few weeks, the situation has been changing from day to day about what is allowed and what is appropriate behaviour in attempting to combat the threat of the coronavirus disease 2019 (COVID-19). By the time this edition of *Inside OR* is published, there may be further significant developments that affect the ways we are able to live and work.

A lot is still unknown about COVID-19, but as a virus, it communicates well: it seems to have the property of being able to multiply and spread rapidly through a population unless mitigated in some way.

The crisis has emphasized the need for good communications on the part of the government to get its message over clearly and to communicate the reasons for its policies. Graphs and charts are also being used by news media to illustrate what is happening. Here is a link to one example from the BBC, though the numbers will now be out of date: <https://bit.ly/CV19health>

Simplified simulations are also being used to illustrate the effect of different strategies. For example, here is a link to an article published in the Washington Post: <https://bit.ly/WPostsimulator>

The article includes a simulation of a simplified model of a disease they call “simulitis” and illustrates the effects of different strategies to slow or stop its spread through a population. Although based on a simplified model, the article is a good example of the power of visual simulation for communicating the results of alternative actions.

“Many of us have had to get used to new ways of communicating with others while self-isolating at home.”

Many of us have had to get used to new ways of communicating with others while self-isolating at home. There has been a surge in the use of Skype, Zoom, Teams and other forms of software designed to enable us to be able to communicate well, despite not being physically in the same place. After the current crisis is over, will these communication methods be used more in the future? Will travelling to meetings and conferences be entirely replaced by on-line communications? My personal view is that there will be some increase in the use of software to enable on-line meetings instead of travelling to meet in the same room or conference venue. However, I do not think that all such meetings will disappear. Even though the on-line software is effective, particularly for formal presentations and discussions, it is often the informal conversations and interactions that take place around meeting together that are at least as valuable as the more formal part of the programme.

I can still remember an example from the OR conference in Durham in 1985 when I attended an excellent tutorial given by Dominic de Werra on the subject of Graph Theory. I remember very little of the tutorial, but I do remember chatting afterwards with Dominic and others about a new technique for trying to solve hard discrete optimization problems that later became known as Simulated Annealing. This gave me an early insight into a research topic which has subsequently been found to be useful in tackling challenging optimisation problems in many application areas. I don't think I would have picked that up from only participating in the conference on-line.

The ways to combat COVID-19 without a vaccine being available rely on slowing its rate of spread so that the NHS has a chance to treat patients without being overwhelmed. Behind the expert advice is a lot of modelling by epidemiologists and other scientists. Modelling is our stock-in-trade and it will be interesting to find out in the future how many people associated with OR through GORS or the NHS have influenced the models being used. OR was forged in wartime. Our current experience resembles a war situation, with scientists from many different backgrounds working together to beat the virus.

Some of you may have responded to the message circulated by The OR Society on 30 March 2020 informing us that the Royal Society has put out an open call for modellers to help with the understanding of the spread of COVID-19 and the impact of government measures. The initiative is known as Rapid Assistance in Modelling the Pandemic: RAMP and I hope that by the time you read this, it will have been able to start contributing.

Modelling, whether using mathematics or simulation or other tools, is a powerful weapon in guiding decisions until a vaccine is found. Our publisher, Taylor & Francis, is playing a part in making research relevant to COVID-19 available. Details are available from this link: <https://bit.ly/taylorandfrancisCV>

The OR Society is also hoping to develop material on our website that will share resources to help those involved in COVID-19 related work.

Do these responses to the coronavirus crisis illustrate the benefits of moving to open access to research to replace the subscription model currently used for much academic publication?

The issue of moving to open access models for communicating research has recently been discussed, provoked particularly by

the publication of Plan S, proposing a move to new publication models that allow funded research to be freely available to all instead of being protected behind a paywall. UKRI has recently launched a draft policy on Open Access and a consultation process, which could have a significant influence on scientific publications and the journals in which the articles are published.

What is a reasonable cost to the taxpayer for funded research to be made available for others? Has the use of commercial publishers led to increased costs? Can insistence on Open Access be a way of making costs of publication more transparent? Can they be reduced?

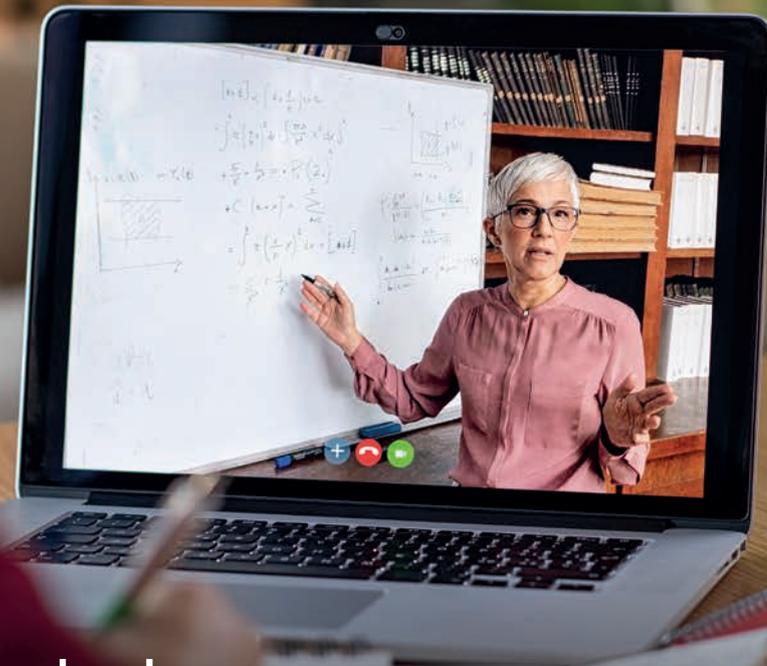
Although some costs have reduced over the years, such as the number of printed copies required and consequent reductions in production and physical distribution costs, there are still costs associated with publications that are important to be covered if the research is to be communicated well. For example, efficient software support for editors to manage the increasing number of submissions must be maintained, researchers need to be able to find relevant articles on topics that are already of interest, articles in new areas need promoting and all articles need proper conservation for the future.

Details of UKRI's consultation can be found on the following link: <https://bit.ly/ukrifunding>

A video of the launch meeting to provide further information and guidance is also available from this link: <https://bit.ly/UKRIlaunchYouTube>

The final policy of UKRI will affect where researchers send their papers to be published, and eventually could affect the reputation and esteem in which our journals are held.

The deadline for responses to the consultation has been delayed by the coronavirus crisis, so the deadline is now 29 May 2020. The OR Society, like other learned societies and other interested bodies, is preparing a response and we are interested in hearing views from our member community. If you have personal views about this issue or have insights from being involved in preparing a response for your own university or other institution, then it would be great to hear from you. Just send me an email on R.Eglese@lancaster.ac.uk and we can see how your contribution can be taken into account. 



OR in Lockdown: Some OR Experiences

RUTH KAUFMAN FORS, OBE

If you're as nosy as I am, you will always be keen to know how other people are experiencing events that touch us all, whether to compare, contrast, envy, sympathise or be inspired. In the absence of the gossipy catch-up (aka networking) that is part of physical events, I present here the findings of a totally non-random, absurdly tiny email survey of a handful of OR people. At the speed with which the world has been changing, there is every chance that by the time you read this, things will be very different, so please bear in mind that this survey took place during the first few days of April.

People's experience varies enormously, depending on their personal and professional circumstances. But if we could encapsulate the shared experience in just one phrase, it would be: "Until recently I thought Zoom was just an ice lolly" (Paul Harper, Cardiff University)

Paul continues, "Now I seem to be on it all day, every day, although with five of us in the house competing for two computers, the Wi-Fi continually dropping, and a cat who makes unannounced but amusing appearances on my calls, life is certainly interesting and trying to keep sane is somewhat challenging. I'm delighted however that, at the request of the Chief Scientific Advisor for Wales, we have been able to use OR in some small way to the help locally with the current crisis. I'm full of admiration for all the wonderful, dedicated NHS staff at this difficult time."

Emel Aktas's experience at Cranfield University is probably common to many university staff, "... we have swiftly transitioned into online lecturing immediately after the government's advice to work from home. We are currently delivering synchronous lectures and recording these deliveries to make them available on-demand

for people who may not be able to attend the lecture. For this purpose we use a mix of Zoom and MS Teams. We continue to hold our work meetings on Skype for Business and emails are operational as expected. We are striving to minimise the disruption and working from home has not significantly impacted our operations. We now have frequent online meetings to keep the morale and coordinating with the government to provide support in ventilator production."

For Emel, "it was easy enough to transition into the new working environment. We have been doing some online teaching already and many business meetings have been held online, but now we increased the extent of these activities. Sometimes the connection quality is poor due to many people using the bandwidth at the same time, but everybody I have conversed with so far have been super supportive and understanding."

Christine Currie, at the University of Southampton, has a slightly different take on the changes, "I really do miss seeing our students and the bustle of the university campus. Research can carry on much as usual, just with video calls rather than face to face meetings – no scope for scrawling on a blackboard though! A group of us have put a paper together on how modelling can help reduce the impact of COVID-19 for the Journal of Simulation (<https://bit.ly/christinecurry>). This was done in just two weeks via late night Skype calls and remote editing of a Google doc. The latter was particularly fun as it allows for simultaneous typing."

It's not just universities. Rosemary Byde at RBS says, "As office workers for a large corporate, myself and my teams are used to working from home already. The business resilience plan has worked well and we're all busy Zoom-ing – with just a few

more virtual coffee catch-ups in the diary! This has come at a time when we were already going through a lot of organisational change. The crisis has impacted as people's time and attention are diverted to necessary analysis and support work. I'm looking forward to the next Heads of OR and Analytics Forum in May, where we'll be sharing examples of how we've used OR and analytics to help respond to the challenges COVID-19 has created. This will be run virtually, as was the last OR Society committee meeting. One positive that I hope will last is wider knowledge of how to make remote meeting attendance work for everyone – opening up opportunities for people to participate whilst reducing travel and environmental costs."

As these contributors make clear, it's not just about location, but about work content – OR people are involved in directly addressing the crisis. Indeed, every OR person will see that OR skills should be right at the heart of tackling the COVID-19 response. We are even seeing OR people, like doctors and nurses, coming out of retirement to lend a hand to the national modelling and data science effort. The OR Society's COVID-19 webpages <https://www.theorsociety.com/coronavirus-covid-19/> give an idea of what is going on in the public domain, but there is a lot going on inside organisations too.

For example, the massive increase in benefits claims has impacted significantly on the demand for Department for Work and Pensions frontline services, with knock-on increase in workload for the modellers directly involved, but also changes in work pattern for others. Aidan Cross, Head of Profession for OR at DWP, says, "I've been trying to balance my responsibility to provide analysis to support the delivery of our services with my role as Head of Profession to provide support and pastoral care for Government Operational Researchers. Things like promotion rounds, performance reviews and access to professional development all need to be re-thought now that most of us are working from home. An increasing number of us are being retrained to support our frontline services to deal with the increase in demand. I've recently undertaken my training and have volunteered some additional time to help process Universal Credit claims to make sure people get the money they need."

Another example comes from Sandra Weddell, Transport Modelling Manager of Transport for London where the team are "Learning to use video conferencing across multiple organisations to develop public transport industries understanding of rapid demand changes as radically different travel patterns emerge. Developing deep understanding of the new passenger flows which need to be supported with analysis in that needs to be done in the same number of hours as it took months, to support timetable changes developed in days that used to take years".

If your personal circumstances allow, the experience can be positive. Andy Harrison says he is enjoying working from home, "no commute, my own office (none of the distractions of an open plan office) and more time with my family. When this is all over I doubt I'll want to go back into the office and I'll have proved that I don't need to be in the office to be productive."

And Ian Seath, independent consultant, "Most of my face-to-face client work disappeared in the space of three days but that's freed me up to devote more time to my pro bono role as a



Director of the Kennel Club. It means I have been able to support the Executive Management Team as they deal with business continuity matters. I feel like I can devote good chunks of time to this, instead of 'fitting it in' which was often the case when I was busy. A friend said: 'if this is what retirement looks like, I could get quite used to it!'

Jane Parkin has chosen to make these dangerous times even more dangerous, "Now spending much of my days atop a ladder weather-proofing the outside of our 400-year-old farmhouse. Only slightly lamenting the loss of a cancelled overseas job" but as Jane goes on to say, "I'm one of the lucky ones: I received a letter today from Civil Service Pensions saying 'Please rest assured, the payment of your pension will not be affected by the current situation!'"

And finally, some of the more personal thoughts from some of my correspondents. Emel, "I try to keep positive despite worsening news and connect with students and colleagues as much as possible....Now that mobility is constrained, I follow yoga sessions from Nike Training Club, just to have a bit of a stretch every day. We keep calm and continue as much as we can." Aidan, "Living in rural High Peak, village life hasn't changed significantly through Lockdown... I'm a keen cyclist and very grateful that I'm permitted to cycle by way of daily exercise on what are now emptier roads. ... One of the main differences is that we've taken on a lodger, a young Jordanian student who can't get home and is staying with us until the airports open again. We've been teaching him how to cook Italian food and he's been telling us about the life of his friends and family under military curfew back home."

And giving Rosemary the last word in a piece that started by being a substitute for face-to-face networking, "What I've found particularly useful is using my networks for mentoring, including those within The OR Society. This has been important in giving me an external perspective and maintaining a sense of balance in uncertain times." If you want to get more engaged in OR networks, explore the Society webpages and you should find plenty of opportunity. 

Your chance for glory

Nominations and submissions are still open for these OR Society awards!

Doctoral Award 2019

Deadline for submission:
23:59 on 31 May 2020

The OR Society is currently seeking the Most Distinguished Body of Research leading to the Award of a Doctorate in the Field of Operational Research for 2019. All OR-related PhDs defended or approved in a UK university during 2019 are eligible to be nominated for The OR Society's Doctoral Award.

A completed entry must include the following documents:

- A nomination from the external examiner of the thesis.
- An extended abstract written by the student.
- A report from the supervisor of the student.

The winner is awarded a cash prize of £1,500 and their name engraved on the George Patterson Shield. Up to two runners-up each receive £500. More information:

www.theorsociety.com/DoctoralAward



President's Medal

Deadline for submission: 30 June 2020

The President's Medal is awarded for the best practical application of OR submitted to the competition (a wide definition of OR is used). Entries are welcomed from both industry-based OR workers and consultants as well as from academics. One of the main qualifications for entry is that the work has been implemented before submission. Criteria for judging include the level of demonstrable benefit, the intellectual and novel content of the solution, the likely longevity of the solution and the excellence of the OR process.

Find out more at www.theorsociety.com/PresidentsMedal



Lyn Thomas Impact Medal

Deadline for submission: 31 July 2020

The Lyn Thomas Impact Medal is awarded for the academic OR research which best demonstrates both novelty and real-world impact, backed by evidence. Impact can be in many spheres of life, benefitting social, economic, cultural, political, educational, physical or artistic quality of life, and this medal celebrates the role of OR in making a difference.

The underpinning research should have been undertaken in the previous ten years and the impact itself must be demonstrable within the past two years.

Find out more at www.theorsociety.com/LynThomas





Modelling: triaging patients who need intensive care

A new computer model has been developed which analyses when to admit people to intensive care units (ICUs) and when to move them out. The model could help doctors handle the coronavirus surge in hospitals.

In February 2020, a study appeared in *Operations Research*, which illustrated how mathematical modelling could be used to determine which kind of triage policy could be useful in an ICU during such surges.

The study looked at those circumstances in which patients could be queued for admission to a hypothetical ICU with limited beds or transferred to a general ward as their condition changed. The goal of this research was to find a heuristic for clinicians that minimised the average mortality rate of all patients over time, which is, after all the goal, of triage all over the world.

According to Laura Albert, a system engineer at the University of Wisconsin, “a lot of times medical professionals are really focused on making this one decision for the patient who is right in front of them. It’s hard when I must ask the patient to wait because that will save many more lives across the system. These heuristics are really valuable for service providers because otherwise it is so hard for them to make that call in the moment”.

By using computer simulations, the researchers, applied a heuristic that determined who should be admitted to an ICU bed by estimating how much each patient’s chances of survival increased by being there and then dividing the figure by the

number of days that person would probably need to stay in an ICU bed. Those individuals whose ratio was highest were prioritised, and the researchers also examined how the heuristic worked when additional patient health conditions were added.

The research compared the heuristics’ collective mortality rates with those of possible triage scenarios – one policy provided beds on a first-come, first-served basis. Another discharged patients who were the least likely to be worse off in a general ward to make room for new ones, and a third policy approach, randomly discharged people from the ICU when new patients arrived.

During the research it was determined that the ratio heuristic prioritised patients who were expected to receive the highest benefit for each day they occupied an ICU bed. The study’s co-author on this heuristic, Nilay Argon, an OR specialist, University of North Carolina, says that it was particularly valuable when an individual’s state improved or worsened during his or her stay.

Argon went on to say that as soon as they change state, then their triage should be applied again. Prior to this research, previous models of triage decisions in ICUs had not considered a patient’s condition changing. This could help reduce bed blocking including helping to decide when to move a patient to palliative care.

In the case of COVID-19 patients, a patient moved out of ICU still needs to be held in quarantine until they are no longer infectious. 

More at: <https://bit.ly/TriageModelling>

COVID-19 a lesson to be learnt

DENNIS SHERWOOD, DIRECTOR, SILVER BULLET

To gain their readers' attention, the authors of many of the texts on systems pose this teaser:

Pond-weed doubles every 24 hours. If a pond is completely covered by the end of day 30, at the end of which day is the surface half-covered?

The infestation can be arrested using an eco-friendly remedy that acts within minutes once applied, but has a lead-time of 10 days for delivery. What proportion of the pond's surface is covered at the end of the latest day on which the remedy can be ordered so that the pond does not become completely choked?

Many of those learning about systems are surprised to discover that the "obvious" answer for when the pond is half-covered, "day 15", is wrong, and that the correct response is day 29. And as regards the proportion of the surface covered with 10 days to go, even more startling is the contrast between the naïve answer, "one-tenth", and the correct answer, "one over two to the power ten", $1/1024$ – only about one one-thousandth of the surface. Yes, when growth is exponential, action needs to be taken on very weak signals, for the consequence of delay is to be overwhelmed.

The realities of positive feedback are of course familiar to all reading this, but apparently not to some others, notably Boris Johnson, Dominic Cummings, and their acolytes.

I write this on the evening of 26 March, rather moved by the television coverage of the applause erupting around the country at 8 pm in recognition of health workers and carers. I then watched Question Time, which included as panellists Robert Jenrick, the Secretary of State for Housing, Communities and Local Government, and Dr Richard Horton, the editor of the medical journal, *The Lancet*.

One of the questions enquired as to why orders for key items such as testing materials, personal protection equipment, and ventilators had been made so late, resulting in the shortages currently being experienced, and the threat to life.

Robert Jenrick gave his oh-so-well-rehearsed recital of the official script, saying that, over the previous 48 hours, 15 million face-masks had been distributed to every corner of our green-and-pleasant land. An impressive number; but in the (deliberate?) absence of any information on consumption, an answer of little use. Nor was it the answer to the question "Why the delay?" as asked, but rather to the question he wished had been asked "Would you please be kind enough to tell us how many masks have just been distributed?"

Dr Horton, however, wielded his lancet with precision. "It's a national scandal," he said, "In the last week of January, we knew that a new virus, with pandemic potential, was hitting cities in China, and that people were dying. We then wasted February, when we could have acted. We didn't." Ah. The not-so-weak signal at the early stage of exponential growth. A signal that was ignored.

We all know that the effects of COVID-19 are devastating, and we all grieve for its victims. And it will be many, many months before things get back to normal. But what will "normal" look like? Will it be the status quo as at, say, three months ago? Or will it be a new, different, "normal", in which some of the experiences of the current times are continued? Some thought-provoking ideas were explored in a blog posted on 23 March by cricket buff, puzzler, and Institute of Maths Zeeman Medal winner, Rob Eastaway, <https://bit.ly/Eastawayblog> Might there be much less air travel in the future, with the benefit of a significant and sustained reduction in carbon dioxide emissions? Might remote learning revolutionise schools and colleges, breaking free from the centuries-old model of "studying at the foot of the master"? Might local communities become more mutually supportive and caring?

Possibly; and the world could well become a better place as a result. But I am not holding my breath. The enforced paralysis of economic activity certainly has some beneficial side-effects, not least the reduction in air pollution, attributable to the sudden fall-off in the use of vehicles (see, for example, <https://bit.ly/PollutionReduction>). But such effects are diffuse, and do not obviously benefit "me" – unlike my immediate loss in income, and my fear of longer-term unemployment, that impact me, personally, now.

My hunch is that, once the virus is no longer a general danger, there will be a world-wide social and political imperative to re-build economies as quickly as possible. The planes will be back in the air, the cars will return to the roads, and power stations will be generating at full pelt, with once moth-balled fossil-fuelled plants back on, "because we need as much power as we can produce", regardless of the emissions. So I'm pessimistic about the extent that "we" in general, and politicians in particular, will learn from the current troubled times.

So let me make a plea. That if the politicians were to learn only one lesson, that it is this: when a system is driven by positive feedback, it is imperative to take decisive action early, on inevitably weak signals, for the consequences of delay can be overwhelming. Especially when that system is the planet-as-a-whole, and the positive feedback is driving an increase in the average global temperature.

A key feature of the COVID-19 crisis is the speed of the positive feedback. When the number of new infections, and the number of deaths, each double every three days, there is immediacy, urgency; an immediacy and urgency that results in the commitment of vast funds (the US announced economic support of \$2 trillion on 25 March) to help remedy the problem.

By contrast, the positive feedback associated with global warming is glacially slow (please forgive that metaphor!). So the impact of global warming is much less dramatic, much less visible, despite the photographs that prove just how fast those glaciers are melting.



The signals, originally weak, now much stronger, have been there for many years. Most of the key observations and analyses were known in the 1970's: Nathaniel Rich's *The Decade We Could Have Stopped Climate Change*, for example, gives a chilling account of how the scientific evidence was denied, challenged and utterly dismissed during the 1980s. And Margaret Thatcher warned the world in a speech to the General Assembly of the United Nations on 8 November 1989: to select just one sentence, "We are seeing a vast increase in the amount of carbon dioxide reaching the atmosphere" <https://bit.ly/MThatcherUN> yet even Margaret Thatcher was ignored.

The effects – personal, social and economic – of the current crisis are already catastrophic, and will become even more so. But compared to the likely effects of runaway global warming, what we are experiencing now is but a side-show. Pages 12 to 14 of the November 2019 issue of this journal <https://bit.ly/InsideORNov19> presents some causal loop diagrams, showing that a progressive increase in the average global temperature will drive famine, disease and war, let alone the devastation, and possible extinction, of many species.

Fundamentally, global warming is a stock-flow problem. The average Earth temperature is determined by the stock of greenhouse gases, and especially carbon dioxide, in the atmosphere. This stock is increased by two main inflows, the carbon dioxide produced by animal respiration and by man-made emissions, and depleted by one main outflow, the carbon dioxide consumed by photosynthesis, of which one particular

form, carried out by marine algae known as coccolithophores, is especially important, for the end result is the formation of chalk and limestone, the carbon content of which was originally atmospheric CO_2 . As vividly described by James Lovelock (see, for example, his book *Gaia – The Practical Science of Planetary Medicine*), over the last billion-or-so years, this coccolithophore-mediated 'living pump' has controlled the stock of atmospheric CO_2 , so maintaining, a stable global temperature. But over the last 100 years, the rate at which man-made emissions have injected CO_2 into the atmosphere has exceeded the rate at which the 'living pump' can extract it, with the result that the atmospheric stock of CO_2 has steadily increased, driving the Earth's temperature ever upwards. The solution is therefore to supplement the 'living pump' with technologies that extract CO_2 directly from the atmosphere. Some technologies have been trialled, notably those of the ETH spin-out, Climeworks (www.climeworks.com), which is a good start, but nowhere near enough.

What, then, is 'enough'? My answer is this. The UK government should commit, now, to fund an Apollo/Manhattan-style programme, bringing together the world's scientists, technologists, engineers, industrialists, and others as required, tasking them over the next five years to deliver as many ways of extracting greenhouse gases directly from the atmosphere as they can – ways that can be deployed, at scale, around the world. The cost? How about £100 billion? That just happens to be the currently-estimated cost of HS2. Do you want to take 20 minutes off the rail journey to Birmingham, or to save the planet? 

OR62 and COVID-19

JUERGEN BRANKE AND FRANCES O'BRIEN – OR62 CO-CHAIRS

With the recent developments around the COVID-19 pandemic, the closure of borders and the tightening lockdown of life in the UK, the OR62 organising committee had to consider the implications this would have on the conference.

Of course nobody can tell right now how the situation will develop in the future and whether government rules might have lifted by September. But even if the conference would be allowed to take place, would researchers submit abstracts, would they consider it safe to attend a conference, and would they have time to attend a conference after having spent months in isolation at home? Based on all the information we have at the moment, it seems unlikely that the usual face-to-face annual conference of The OR Society could be run successfully.



We have thus decided that it would be best to cancel this year's OR Society conference.

Instead, we are planning to offer an exciting online event to take place in the same timeframe. Preparation of this online event is underway and more information will be released soon, so stay tuned. The University of Warwick will now host what will be OR63 in September 2021. 

Forget OR62, get ready for OR62 online!



Improving the vision and self-awareness of self-driving vehicles

The first truly autonomous cars appeared in the 1980s, with Carnegie Mellon University's Navlab and ALV projects in 1984 and Mercedes-Benz and Bundeswehr University Munich's Eureka Prometheus Project in 1987. Then, as now, autonomous vehicles relied heavily on machine vision and self-teaching neural networks.

Autonomous vehicles can also learn to drive themselves by watching/mimicking humans with the help of sight-correcting systems and new neural network technologies. The goal of such technologies and using them to mimic human behaviours, could lead to self-driving cars being developed that 'learn' just by observing human operators completing the same tasks.



Researchers from Deakin University in Australia published the results of research done on improving autonomous driving systems with such technologies, in *IEEE/CAA Journal of Automatica Sinica*. Their study illustrated how the implementation of 'imitation learning', could be used with human operators driving vehicles, each fitted with three cameras, that observed their operating environment from the front and each side of the car. The data from these cameras is then processed through a neural network that allows the vehicle to make decisions based on what it learned from watching humans make similar decisions.

According to study co-author, Saeid Nahavandi, Deakin University, "The expectation of this process is to generate a model solely from the images taken by the cameras. The generated model is then expected to drive the car autonomously."

The processing system developed during the research was specifically a convolutional neural network (CNN). The network was designed to incorporate an input layer, an output layer and any number of processing layers in between. Visual information is transformed into dots, which are then continuously compared as more visual information comes into the network.

By reducing the visual information, the network could quickly process changes in the environment: a shift of dots appearing ahead could indicate an obstacle in the road for example. This, combined

with the knowledge gained from observing the human operator, meant that the algorithm could 'know' that had to brake.

According to Nahavandi, "Having a reliable and robust vision is a mandatory requirement in autonomous vehicles, and CNNs are one of the most successful methods for image processing applications".

CNNs require a significant amount of training data to find an optimal configuration of layers and filters to generate models capable of driving an autonomous vehicle. Increasing the number of filters does not necessarily result in a better performance. The optimal selection of parameters of the network and training procedure is still an open question that researchers are actively investigating worldwide.

The research continues and the next step will involve researchers studying more intelligent and efficient techniques, including genetic and evolutionary algorithms to obtain the optimum set of parameters to better produce self-learning, self-driving vehicles. 

The study, Deep imitation learning for autonomous vehicles based on convolutional neural networks, can be found in *IEEE/CAA Journal of Automatica Sinica* (2020). DOI: 10.1109/JAS.2019.1911825.

You can access a paper on it, in PDF file from: <https://bit.ly/AutoSinica> [there may be a charge involved to access this paper]

Rolling Horizon Simulation

Rolling horizon scheduling for operating theatres

A paper on simulation technologies for hospital planning has recently been published by Anders Reenberg Andersen, Thomas Jacob Stidsen and Line Blander Reinhardt. The paper provides insight into how simulation modelling can be applied to problems that incorporate rolling and overlapping planning horizons.

The three scientists took as the basis of their modelling approach to these types of problems, a Markov design process, and applied this to the type of problems that are frequently encountered in hospitals, problems where patients are scheduled to a date and room on a daily basis.

They tested the potential of using such a modelling approach on the resulting hospital costs and number of patients that were outsourced to avoid violating constraints on capacity. The data that was used for this simulation research was obtained from a Danish hospital. The design of the modelling fully acknowledged that both state and action space were only partially observable.

The purpose was to offer insight into how to: increase the number of surgical procedures available to patients; reduce waiting times; improve resource utilisation for operating theatres and; to maximise the efficiency of staff resources.

In addition to the data used from the Danish hospital mentioned, the researchers also held interviews with stakeholders involved in making such decisions in hospital environments. They found that annual planners had a time-consuming and complicated task at hand – indeed hospital planners had to ensure that equipment in the room, for any patient, was compatible with the surgical procedure for that patient – a not inconsiderable task!

When making such planning arrangements they also observed that patients should be treated by the same surgeon they were examined by and that the waiting time did not violate a 'hard' upper limit. The objective of the study was refined further: to provide hospital planners with a decision tool capable of optimising the schedule of patients for operation, whilst respecting constraints that were relevant to the hospital under observation for the simulation.

For the purpose of the simulation and route to the design of the decision making tool, the researchers considered only that 'rolling and overlapping planning horizons' would be taken into account –



thus the decisions that were made on each day had to be anticipative.

Focusing on short-term operational level of planning, they found a range of different approaches and problem structures. Considering the problem of allocating patients to day and room as a sequential decision problem with overlapping planning horizons, seemed to work well, and led the research to assume that surgical operations could begin at any time within the opening hours of the operating room and even stretching to over time.

A period of 365 days was used to "burn in" the simulation, and 200 days to assess the performance of the model which resulted from this research. Simulation revealed that 'distinct improvement' could be attained if the model was employed rather than scheduling requests manually, and a substantial improvement could be attained by employing a policy that accounted for future requests by weighting their contribution to the overtime costs – this the researchers referred to as the Anticipative Weighted cost Policy (AWP). 

More at: <https://bit.ly/RollingHorizon>

AI Connecting Dots

The Search for COVID-19 vaccines

Scientists are searching for a vaccine for COVID-19. Vaccines imitate infections, causing the body to produce defensive white blood cells and antigens. In vaccine research there are three main types of vaccine that can be produced to protect humans from infections: whole pathogen vaccines; subunit vaccines and nucleic acid vaccines.

Pathogen vaccines use killed or weakened pathogens to elicit immune responses. Subunit vaccines include only the components or antigens that best stimulate our immune systems. Thirdly, nucleic acid vaccines are designed to introduce genetic material encoding the antigen or antigens against which an immune response is sought – our bodies' own cells then use this genetic material to produce the required antigens to provide immunity.

In the quest for a COVID-19 vaccine the focus has been primarily, on nucleic acid vaccines. These are relatively quick and easy to produce, taking perhaps only months rather than years to develop and make available. AI can be used to accelerate the development of subunits and nucleic acids.

An essential part of a virus's proteins is made up of the sequence of amino acids that determine a unique 3-D shape. Understanding the structure is essential to understanding how they work. Once the shape is fully understood, then it becomes easier to develop drugs that work with that protein's unique shape, but there are millions of possible shapes to search through to find the 3-D structure unique to COVID-19.

In January this year Google's DeepMind project introduced AlphaFold, a system that predicts the 3-D structure of proteins based on genetic sequencing information. In March this year AlphaFold was put to work on COVID-19 which produced a number of potential structures.

At the same time, scientists at the University of Texas and the National Institutes of Health created the first 3-D atomic scale map of the part of the virus that approaches and infects human cells – the spike protein. The scientists had already spent years working on other coronaviruses, which included SARS-CoV and MERS-Cov. One of the predictions released

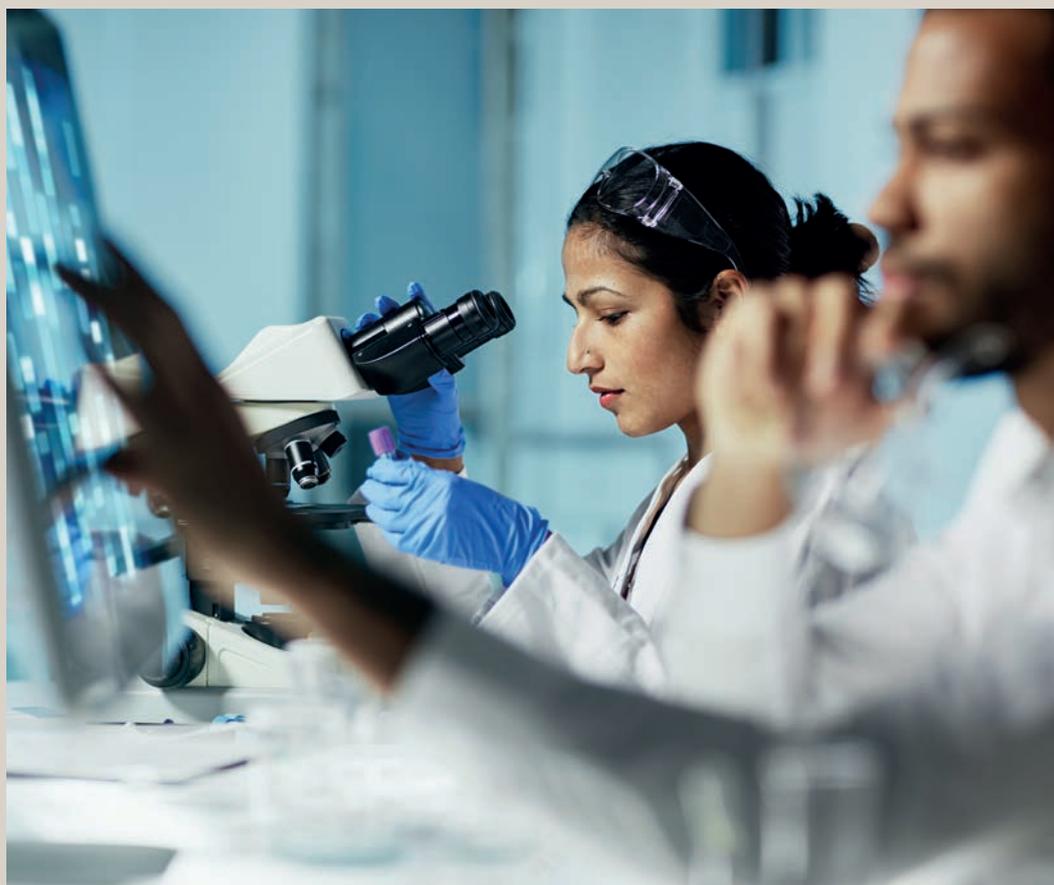
by AlphaFold provided an accurate prediction for the spike protein structure.

Several thousand papers relevant to COVID-19 have appeared in the first three months of 2020. Some of the work has much in common, some not. AI can be useful in sifting through the information stored in these papers, for making connections between research efforts, uncovering insights, and for 'joining the dots' between some areas of research which may seem disparate, until AI discovers possible connections between them.

To facilitate this process, Google's machine learning and data science platform, Kaggle, is hosting the COVID-19 Research Challenge. The aim of this is to provide a broad range of insights about the pandemic.

The research challenge was only released on 16 March, 2020, but within five days it had already gathered over 500,000 views and been downloaded more than 18,000 times – these figures grow daily and findings from the research community are curated on a single webpage connected to it, for quick reference. [or](#)

Automated analysis of scientific literature could be key in finding the tools we need to combat this most recent pandemic. More at: <https://www.kaggle.com/>



OR Society COVID-19 website pages

All COVID-19 related pages focus on sharing wider resources to support those involved in specific work, opportunities to get involved and ORS e-learning.

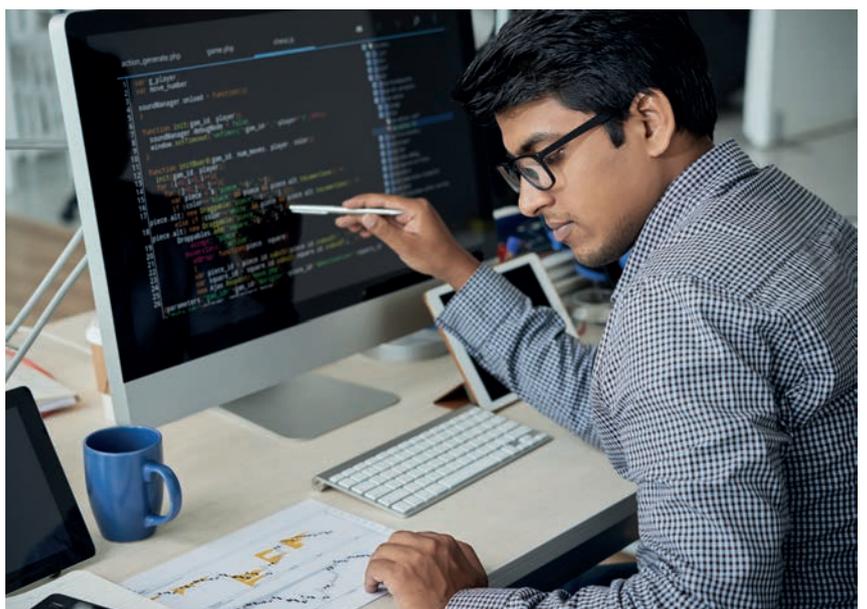
■ COVID-19 resources

Working on COVID-19 projects, or interested to find out what's going on?



■ E-learning resources

Online opportunities and resources to support your learning and development. There's even some help for those of you homeschooling your children.



■ Opportunities to get involved

Want to get involved with some of the COVID-19 related initiatives.

Visit <https://www.theorsociety.com/coronavirus-covid-19/>

Neural networks speeding optimisation in new materials search

Sorting through millions of possibilities, a search for battery materials delivered results in five weeks instead of 50 years

New research from MIT shows how adoption of a Machine Learning (ML) approach could pave the way to dramatically streamlining the discovery process, when searching through theoretical lists of possible new materials for particular applications, such as batteries or other energy-related devices and where there are multiple criteria that need to be met and optimised at once.

As a demonstration, a team led by MIT professor of chemical engineering Heather Kulik, together with Jon Paul Janet, Sahasrajit Ramesh, and graduate student Chenru Duan, arrived at a set of the eight most promising materials, out of nearly three million candidates, for an energy storage system called a flow battery. This culling process would have taken 50 years by conventional analytical methods, they say, but they accomplished it in five weeks.

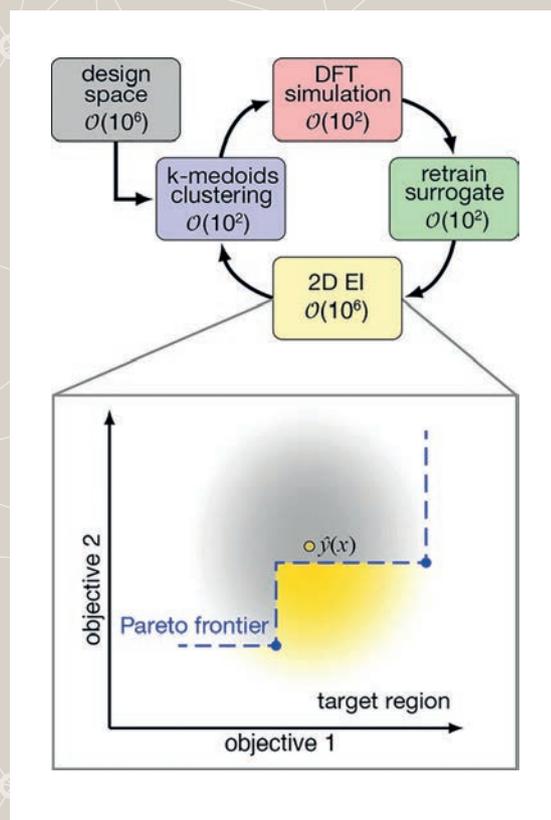
The study looked at a set of materials called transition metal complexes. These can exist in a vast number of different forms, and Kulik says they "are really fascinating, functional materials that are unlike a lot of other material phases. The only way to understand why they work the way they do is to study them using quantum mechanics."

To predict the properties of any one of millions of these materials would require either time-consuming and resource-intensive spectroscopy and other lab work, or time-consuming, highly complex physics-based computer modelling for each possible candidate material or combination of materials. Each such study could consume hours to days of work.

Instead, Kulik and her team took a small number of different possible materials and used them to teach an advanced machine-learning neural network about the relationship between the materials' chemical compositions and their physical properties.

That knowledge was then applied to generate suggestions for the next generation of possible materials to be used for the next round of training of the neural network. Through four successive iterations of this process, the neural network improved significantly each time, until reaching a point where it was clear that further iterations would not yield any further improvements.

This iterative optimisation system greatly streamlined the process of arriving at potential solutions that satisfied the two conflicting criteria being sought. This kind of process of finding the best solutions in situations, where improving one factor tends to worsen the other, is known as a Pareto front, representing a graph of the points such that any further improvement of one factor would make the other worse. In other words, the graph represents the best possible compromise points, depending on the relative importance assigned to each factor.



Training typical neural networks requires very large data sets, ranging from thousands to millions of examples, but Kulik and her team were able to use this iterative process, based on the Pareto front model, to streamline the process and provide reliable results using only the few hundred samples.

In the case of screening for the flow battery materials, the desired characteristics were in conflict, as is often the case: The optimum material would have high solubility and a high energy density (the ability to store energy for a given weight). But increasing solubility tends to decrease the energy density, and vice versa.

The neural network used was able to rapidly find 'promising candidates' to assign levels of confidence to its different predictions through each iteration, which helped to allow refinement of the sample selections at each step. 

You can read more about this research by downloading a PDF from: <https://bit.ly/NNetworks>

Doctoral Award Presentation

Doctoral award talk given at Beale lecture

The “curtain raiser” at the annual Beale Lecture is presented by a Doctoral Award winner. This year, that honour fell to Jeeu Fong Tse, aka Yvonne (winner of the 2017 Doctoral Award). Her talk was about a “Hybridisation Search” for a class of Vehicle Routing Problems (VRP).

The VRP is a deceptively simple problem: you start with a depot, a number of vans and a number of customers. The customers are assigned to the vans in such a way as to minimise the total distance travelled whilst complying with the appropriate laws and prevailing conditions.

Yvonne spoke about the use of different types of VRPs and how she determined which methods to use. After briefly describing the more traditional VRPs, Yvonne concentrated on the Capacitated Cumulative Vehicle Routing problem (CCVRP) which is a relatively new variant. It can deal with more complexity and was motivated by the need to service customers as soon as possible.

Its applications include: humanitarian logistics for the transferring of people to a safer place; for delivering food, medical supplies and necessities to affected regions and; dispatching ambulances to patients' locations. It was also useful in school bus routing, and home delivery services to prioritise customers' satisfaction.

The CCVRP's aim was to minimize the sum of the arrival times to customers instead of the total distance travelled. This problem was particularly applicable in emergency logistics, transportation, wireless networks and computing. How long does each customer have to wait until they are served and hence what is the total waiting time for all of the customers on a particular route and then over all of the routes?

Yvonne had replaced calculations of the costs of moves with new formulas; added a 'penalised' neighbourhood reduction scheme; adapted or replaced some neighbourhood structures and; removal operators in the CCVRP's LNS diversification to tackle CCVRP more efficiently.

She then spoke about a 3D variant of the Dynamic Vehicle Routing Problem (DVRP) and about her own proposal for a VRP algorithm which consisted of two stages – an initial solution and then a variable neighbourhood search (VNS) with a multilevel refinement strategy.

Of the methods and findings of her research into these problems, her work had resulted in a novel and effective algorithm which, when tested on small medium and large datasets produced very competitive results. Her data structure and neighbourhood reduction scheme so far, had enabled fast computational times producing a 35% reduction. To conclude she noted that some new local search operators and remote strategies were also introduced to further improve efficiencies.

Jeeu-Fong Sze is Assistant Professor in the International Business School at Beijing Foreign Studies University, China. 

Watch both lectures here
<https://bit.ly/2020BealeLectures>



Jeeu-Fong Sze receives her award from Edmund Burke.

Call for tutors to bid for OR Society Training courses

Are you an expert trainer within an OR discipline?

Invitation to bid to provide OR Society Training Courses in 2021

The OR Society provides a world-class training programme in OR and related disciplines. Are you the next tutor we need to help equip OR people with the latest knowledge and skills?

The OR Society's Training Working Group (TWG) invites you to bid to provide training courses in 2021. All offers of courses will be considered, though there is no guarantee of acceptance. For 2021, courses in the following areas are particularly encouraged:

More generally:

- 'New' areas – help us keep the OR community fresh in its thinking;
- Practical courses relevant to the issues of the day – doing more with less, efficiencies, reducing waste and duplication;
- Advanced courses in more traditional areas, which start from MSc level and take the subject to a specialist level; and
- Courses given by practitioners or those with a good practical knowledge of the subject.

More specifically – such things as:

- Machine Learning and AI
- Courses relevant to analytics: (including such things as Web Analytics – collection and production of statistics); and courses covering Essential Aspects of Analytics and the wider Analytics Landscape
- Decision-making: (including such things as Decision Analysis; Decision Trees; use of models in Decision Making)
- Multi-Criteria Decision Analysis (MCDA) – Introductory and Advanced courses
- Machine Learning and AI
- Cost Benefit Analysis
- Stochastic Modelling

Other courses which we know from experience are likely to do well include 'how to do it' courses such as 'How to build clever models with spreadsheets'. Generic courses such as 'Presentation Skills' are less likely to be accepted unless they have a particular OR theme or focus. There are plenty of 'big-time' training providers who offer these generic courses at much cheaper rates than we can consider.

An information pack is available giving details of The OR Society's terms and conditions for course providers, including:

- the quality framework to which all tutors are expected to adhere;
- the details of course content, target audience etc., that tutors are required to provide;
- the impact of the trainer's fee on the delegate fee for the course and the likelihood of success of bids.

In the past, The OR Society has experienced difficulty in promoting certain courses and in responding to queries about them, on account of the paucity of information supplied by course providers. Failure to provide adequate information may result in a bid being rejected. 

To request a 2021 Tutor Pack, contact Jennie Phelps at jennie.phelps@theorsociety.com

You can also download the relevant forms from our 'Submit Training Bids' webpage.

Closing date for the receipt of bids is 29 May 2020. Bidders will be notified of the outcome at the beginning of July.



OR Society Sponsored Master Scholarships

An update on our master scholarships students

The 2019/20 Masters Scholarship winners are now just over halfway through their masters. Martha is studying at Loughborough while Rebecca is studying at Strathclyde. See how they are getting on, what they are enjoying about their courses and how COVID-19 has impacted their degrees.



Rebecca Eccles

I have been studying Data Analytics at Strathclyde Business School in Glasgow since September, and once again I would like to thank The OR Society for their scholarship which allows me to study full time.

Since it is over 10 years since I did my undergraduate courses, returning to university has been a bit of a shock to the system! Last semester passed in a whirlwind of being thrown in at the deep end learning both Python and R amongst classmates that had finished education more recently than me and who had more relevant undergraduate courses than I did. You will be pleased to hear that I did manage to swim (rather than sink) and I am passing all of my courses comfortably. I found that R was my favourite language and that R studio was very intuitive.

This semester I have been surprised to find how much I've been enjoying my Machine Learning classes (in Python). So much so that I have transferred into the advanced machine learning class. I am finding the classes from the school of computer sciences play closer to my talents (sorry management sciences!), and I have chosen electives that are weighted heavily in that direction.

There are two main reasons that I chose to study at Strathclyde. The first is that there was a double module called data analytics in practice. This module consisted of five real life case studies where external companies came into class and presented us with a problem that they face and do not have the resources to tackle. My classmates and I were split into small teams to undertake the work for them and we analysed the data over 2-3 weeks before presenting it back to the clients. I have absolutely loved the concept of these classes, putting in the hours of work is definitely worth it, and we have all really focussed on these projects. We all have worked much harder on this module compared to any other, and I'm sure the learnings will stand us in good stead for employment come September.

The other reason that I chose Strathclyde for my studies is that the summer internships were also with external clients and we were due to attend their workplaces for the full summer project. Unfortunately, now it seems that these projects will be run remotely. I hope that the employers that would usually have hosted us will remain engaged with the university and that we will still be able to do 'real work' throughout the summer rather than writing dissertations on obscure concepts thought up in a hurry in June! We are permitted to find ourselves an external project, I have applied for a few but unfortunately, they have all been cancelled over the last couple of weeks. If you work for an organisation that collaborates with the universities please remember that the students can't simply delay their projects until the lock down is over, and that there are students out there that will be happy to run a small project on your behalf with only limited input from you. 



Martha McKenna

So far, I have greatly enjoyed my degree. The content of my course at Loughborough has been engaging and challenging, and over the past seven months I have developed both my knowledge and technical skills. This second semester has been particularly interesting for me. The course content has built on the principles and models covered in the first semester, and I am now developing an understanding of the ways in which these principles and models are implemented in practice. I have developed an appreciation of how different statistical modelling techniques are applied and adapted to a variety of real-world situations, which will allow me to better use these techniques in a practical context in my future career.

Another aspect of my degree I am enjoying is the flexibility offered to angle my assignments and projects towards my own areas of specific interest. I have developed an interest in healthcare, and in the myriad ways that operational research techniques can be applied to improve healthcare outcomes and increase efficiency. I am therefore applying the models and techniques learnt in lectures to this context. Whilst healthcare always plays an important role in the public consciousness, the current COVID-19 pandemic has highlighted the importance of analytics and modelling in informing NHS strategy. I am very grateful that my degree has provided me with the technical tools needed to work in this capacity. I have been offered a role with the NHS Digital Academy as a Data Scientist upon my graduation, and I look forward to using analytics in a practical context for the NHS.

Unfortunately, the in-person teaching portion of my degree has come to a premature end. The remainder of my degree will be delivered as a series of online lectures and workshops. I am making the most of the lockdown period by working on my coding skills, and preparing for my exams which will now also be conducted online. The final portion of my course is a large-scale summer research project. This will test the skills and knowledge I have developed so far, acting as a capstone to my degree. Whilst I was excited at the opportunity to conduct an analytical project at an external company, I recognise that this will likely no longer be possible. Nevertheless, I am looking forward to being assigned my project, and to beginning my work on it. 

Obituaries: a tribute to some leading scientists

Tony Lewis MBE

(25 February 1942 – 15 March 2020)



We are sad to report that Tony Lewis, the operational researcher most frequently mentioned in the world's media, has died at the age of 78. Tony Lewis, with his statistician co-developer, Frank Duckworth, devised what became known as the Duckworth-Lewis method for settling weather-affected limited-overs cricket matches. Whenever rain curtails a match the result is announced that A beat B by x runs, according

to what is now known as the DLS method. The L is Tony Lewis. Duckworth and Lewis handed the custodianship of the system to Australian Professor Steven Stern on their retirement in 2014. Tony also gave his name to an Irish pop group, The Duckworth Lewis Method, who released two cricket-themed concept albums in 2009 and 2013.

Tony was a lecturer at the University of the West of England when he and Frank Duckworth came together after South Africa's target in the 1992 World Cup semi-final against England was comically reduced from 22 runs off 13 balls to 22 runs off one ball. Duckworth explained in 2007, "I recall hearing Christopher Martin-Jenkins on radio saying 'surely someone, somewhere, could come up with something better' and I realised that it was a mathematical problem that required a mathematical solution." The first breakthrough was in 1995 when Frank and Tony got the ear of the Chief Executive of the ICC and also that of the cricket secretary of the England and Wales Cricket Board (ECB). They were fairly impressed but asked them to do some more analysis with exclusively international data and to present in July 1996 to the full council of the ICC full of many famous cricketing names. This they did and again succeeded in making a good impression.

After a few months' reflection and another presentation, almost simultaneously Zimbabwe wanted to use the method for England's forthcoming tour and England decided to trial the method domestically for 1997, and shortly after that the ICC decided to use it for their Trophy competition in Kuala Lumpur in 1997. The next year, several other countries took it on board, especially since it was becoming increasingly likely that it would be used for the forthcoming 1999 World Cup in England. So Sri Lanka and Australia, the last of the major countries, came on board to try out the method ahead of the World Cup. It turned out, to everyone's surprise, that the weather in England was fine for the World Cup competition although the method did get substantial use in the warm-up matches.

The ICC, after the World Cup, decided to give the method a two-year full international trial in all countries under its jurisdiction. When the trial was successful the Duckworth/Lewis method became the International Standard rain-rule. Their method allows the target score in one-day cricket to be reset, when there are interruptions to play, usually, but not exclusively, through rain, that result in a shortening of the innings of one or both sides. The system calculates targets based on the batting team's remaining resources – wickets in hand, and overs in hand – via mathematical formulae.

On hearing of his death, ICC General Manager, Cricket, Geoff Allardice, said "Tony's contribution to cricket is huge. The present-day system of resetting targets in international cricket is based on the one developed by him and Frank more than two decades ago. His contribution to the game of cricket will be remembered for years to come and we send our condolences to his family and friends." The England and Wales Cricket Board said in a statement: "Cricket is deeply indebted to both Tony and Frank's contributions to the sport. We send our sincere condolences to Tony's family."

Born in Bolton, Tony graduated in mathematics and statistics from Sheffield University, lectured at the University of the West of England, before retiring as a lecturer of Quantitative Research Methods from Oxford Brookes University. Tony, with Frank Duckworth, was awarded the Goodeve Medal by the Society in 1998 for their paper: Duckworth, F.C. and Lewis, A.J., 1998, "A fair method of resetting the target in interrupted one-day cricket matches," *JORS*, Vol. 49, pgs. 220-227 <http://bit.ly/CricketTarget>

He was appointed a Member of the Order of the British Empire (MBE) in 2010 for service to cricket and mathematics.

Tony was a regular participant in OR Society events. He contributed many talks at regional groups around the country, frequently participated in conferences, and was a regular attendee at the Blackett lecture, most recently in 2018. He always enjoyed the company of his fellow operational researchers. Those who knew him will miss his company greatly, and remember his distinctive smile. Our condolences go to his family, whose grief will be exacerbated at this time of isolation.

His friend, fellow cricket aficionado, and co-author, Graham Rand said, on news of his death, "This is indeed sad news. It was inevitable that our conversations usually started with cricket. Tony watched much more international cricket than I did, with the benefit, no doubt, of his Sky subscription, but, having read the press reports, I could usually contribute to the discussion. However, Tony's interests extended well beyond cricket: to what was happening in universities and to politics, for instance. It was always refreshing to talk with him, an uplifting experience. I will miss seeing him enormously." 

Freeman John Dyson

(15 December 1923 – 28 February 2020)



Freeman John Dyson was born in Crowthorne, Berkshire. He was awarded a scholarship to Trinity College, Cambridge in 1941 but was called up to work in OR for Bomber Command where, amongst other things, he argued that having a tail gunner merely increased casualties. He graduated from Cambridge in 1945. After terms at Cornell, Birmingham (UK) and Cornell again, he ended up as a professor at IAS, Princeton.

Dyson originated several concepts that bear his name, including: Dyson's

transform, Dyson trees, Dyson series, Dyson spheres and Dyson's eternal intelligence. He published many papers and books including: *Disturbing the Universe* (1979); *Origins of Life* (1985) and *A Many-Coloured Glass: Reflections on the Place of Life in the Universe* (2007). 

Katherine Johnson

(26 August 1918 – 24 February 2020)



A mathematician whose calculations of orbital mechanics as a NASA employee were critical to the success of the first and subsequent US-crewed spaceflights. During her 35-year career at NASA and its predecessor, she earned a reputation for mastering complex manual calculations and helped pioneer the use of computers to perform the tasks. The space agency noted her "historical role as one of the first African-American women to work as a NASA scientist".

Her work included calculating trajectories, launch windows, and emergency return paths for Project Mercury spaceflights, including those for astronauts Alan Shepard, the first American in space, and John Glenn, the first American in orbit, and rendezvous paths for the Apollo Lunar Module and command module on flights to the Moon. Her calculations were also essential to the beginning of the Space Shuttle program and she worked on plans for a mission to Mars.

She was the first African American woman to attend graduate school at West Virginia University in Morgantown, West Virginia. In 2015, President Barack Obama awarded Johnson the Presidential Medal of Freedom. 

Ralph Anthony "Tony" Brooker

(22 September 1925 to 20 November 2019)



Tony Brooker, mathematician and computer scientist designed the first programming language for the world's first commercial computer – the Ferranti Mark 1.

In 1943 he won a scholarship to study mathematics at Imperial College London, graduating after just two years whilst spending his nights on the roof of the university's administration building firewatching.

After the war, he began working at the college and switched his focus to chemistry research. But he soon returned to the mathematics department, where he and two colleagues started experimenting with early computer technology and built a machine, they called the Imperial College Computing Engine – "Icky".

In 1949 he moved to the University of Cambridge, where he first explored ways of making computers less difficult to use and became a colleague of Alan Turing. He joined Alan in Manchester in 1951 just after it installed a new machine called the Ferranti Mark 1. His job was to make it usable.

Turing had written a user's manual, but it was far from intuitive. To program the machine, engineers had to write in binary code. While it was neat and very clever, it was also, pretty meaningless and very unfriendly. Brooker wrote a language he called Autocode, based on ordinary numbers and letters. It allowed anyone to program the machine – not just the limited group of trained engineers who understood the hardware.

In the mid-1960s, Mr. Brooker helped design Britain's first computer science degree program, at the University of Manchester. In 1967, he built a similar degree program as the founding chairman of computer science at the University of Essex, where he worked until he retired in 1988. 

OR minus 20

May 2000

The Frog and the Lily Pad

MIKE PIDD

The April newsletter included an interesting contrast. In his editorial, Jeff Griffiths described the work underway to ensure that the history of UK OR and of the Society is properly recorded and preserved. This is important because each generation naturally tends to assume that what it does is real OR. I've always been a browser in libraries, almost never coming out with the books I've gone in to find. I recall, as a student, finding a book that described some of the OR that went on in the Second World War. It was at a particularly barren stage in my education when I knew that I could spot an LP problem at 100 metres, but it all seemed so pointless. It wasn't exactly a road to Damascus experience, but I suddenly saw there was more to OR than mathematical fiddling – which is how I'd come to see it. I realised that OR had a past and it might have a future.

Hans Daellenbach also wrote in the April Newsletter, but his sweep was broader, encompassing the future as well as the past. Hans is respected for his ability to combine mathematical rigour with a systems approach that leads to a practical view of OR. But his prognosis for OR seemed bleak – it would have disappeared some time during the first half of this new century, its methods and approaches taken for granted and used by others.

Most OR people go through an identity crisis at some stage. What do you say at a party when someone asks what your work is (you can tell that I go to middle class parties and not all-night raves). I usually say that I work at the University. I once said this to the producer of Coronation Street after we'd had a few glasses of wine. He then asked, "Fine what do you do there? Are you the Principal or do you clean the toilets?" So I'm now a bit careful with that response. If people persist I say I teach OR. "What's that then?" "Would you like the 10 second, 10 minute or 10 week explanation?" They usually find someone more interesting to talk to at this point.

Some years ago, the Society had one of its periodic attempts to define OR, and this was done by announcing a competition for the best definition. My own favourite was a variation on an example included by Richard Bellman in his book on dynamic programming. The picture is of a frog and a pike

living in a lily pond. From time to time, the frog would hop from one lily pad to another and the pike would stealthily swim to the pad. The pike's intent was clear; he wanted to eat the frog and would snaffle the lily pad if necessary. As the pike opens its jaws to swallow its prey, the frog leaps onto another pad to live a little while longer. For the definition, OR is the frog, and what we do is the lily pad. Other groups will always snaffle what we've been doing – and this is a compliment.

Why do I like this view of OR? It suggests that a core feature of OR is innovation, finding new ways to do things. Helping people to do things more efficiently and effectively. Knowledge work is a fashionable term nowadays and OR people are knowledge workers par excellence. We have to live on our wits and we have to leave things behind for others to get on with and to make routine. This is probably why some OR people make poor managers. We're more interested in developing new approaches and in tackling new problems, than in the day to day work of getting things done.

So back to Hans' piece last month. Does OR have a future? I think it does, but it's up to us. If we don't innovate and if we are not found useful, then we have no future. But I'm much more optimistic than that. I teach some of the future OR workers and I know that these bright people will innovate – we just have to keep them in OR. 

OR minus 30

May 1990

The May 1990 issue of JORS was a special issue devoted to artificial intelligence and expert systems. I have reproduced the "Editorial" in full. Within it, I have added references in the form "[nn]".

If you precede these numbers with jors.1990/nn clicking this link this should take you to the relevant article (provided you have the right access authorities). Members can, of course, access the full issue via the Society website.

Editorial

This special issue on **Artificial Intelligence and Expert Systems** came about as a result of the growing interest in the subject amongst OR practitioners. Doukidis and Paul [63], in their survey of the application of AI techniques within The OR Society, demonstrate that interest. At the request of the editor of the journal, we undertook to produce a special issue of the journal on this subject. We canvassed for papers on a very wide basis, putting advertisements in a number of newsletters and writing to a number of contacts in the area. To our pleasure and surprise we received a large number of letters of intent (over 50 in number), and again to our surprise, the majority of these letters of intent actually became submitted papers. The success of the canvas for papers was such that even with fairly rigorous refereeing, the number of papers accepted and of interest is greater than that in a normal single issue of the journal. Therefore the papers have been split into two special issues.

This first issue, Part I on **Production Planning, Applications and Methodology**, has two papers on production planning by Duchessi and O'Keefe [64] and by Zhang and Lu [65]. Production planning problems are typically dealt with in OR by optimization techniques or by heuristic approaches. These techniques are not as widely used by management as might be expected because they sometimes lack credibility and have high costs and excessive data requirements. In any case, the optimal solution to a production plan is often the solution to an excessively large combinatorial problem. Human schedulers are very adept at producing good feasible solutions. So, for example, Duchessi and O'Keefe's paper discusses the advantage of their specific expert system

approach, in that it incorporates the abilities of an experienced production planner who uses a trial and error method for planning. Their expert system application performs reasonably well for simple problems, but the main benefit of their development is that it demonstrates that a production manager's knowledge can be represented in computer form and can be applied to long-term manufacturing planning problems. Zhang and Lu take a different approach to planning in a manufacturing environment. They have devised an expert system which acts in a management role, by generating a variety of alternative plans based on management criteria and then evaluating these plans to determine the best one to select. The advantage of this approach is that the system is designed to generate alternatives and evaluate them, rather than the slower combination of manual generation and computer evaluation that is more typically applied in these situations.

The next section of this first special issue contains two application papers which are quite innovative. Pierre and Hoang [66] describe an artificial intelligence approach to improve computer communication network topologies. With the increasing use of computer communication networks, the network design problem is increasing in difficulty and therefore growing in importance. Once again the problem is of a combinatorial nature. Their approach is to apply heuristics to drastically reduce the search space of candidate potential topologies of the network. The artificial intelligence system combines conventional approximation methods into a knowledge-based system. Sophisticated goal searches can then be applied to the knowledge base, which in effect provides the basis for large sets of detailed design rules. In contrast to this paper Balestra and Tsoukias [67] present a statistical application. Although the

subject area, multi-criteria analysis, can be considered to be of a very technical nature, the authors have implemented a system which allows for declarative knowledge representation and provides a natural man/machine interface. Many readers will be aware of the very unnatural interface that statistical packages often have!

The final section of this part of the special issue is a methodology section, a necessary component of any mixture of research and applications in such a subject area. The titles of these papers are fairly self-explanatory. So, for example, Connell and Powell [68]

compare the potential applications of expert systems with those of decision support systems; Kiountouzis and Papatheodorou [69] compare distributed artificial intelligence and soft systems; and Neale [70] discusses the modelling expertise that is required in order to improve knowledge-based system development. Whilst these two special issues provide the reader with some understanding of the nature of the work in this area, Doukidis and Paul are also putting together a book to be published later this year, with approximately three dozen papers in it. The book will give a more comprehensive review of the state of the art in the subject area, as well as giving some topic overviews. 

Links:

<https://doi.org/10.1057/jors.1990.62>
<https://doi.org/10.1057/jors.1990.63>
<https://doi.org/10.1057/jors.1990.64>
<https://doi.org/10.1057/jors.1990.65>
<https://doi.org/10.1057/jors.1990.66>
<https://doi.org/10.1057/jors.1990.67>
<https://doi.org/10.1057/jors.1990.68>
<https://doi.org/10.1057/jors.1990.69>
<https://doi.org/10.1057/jors.1990.70>

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Mrs Stephanie Monks

Quintagram

All the answers can be found within this month's articles.
You must use each of these 32 letters once and only once.

A A A A C E E E E H I I K L N N N N O P P P R R S S T U V Y Y

1. Who has gone to the dogs? (5)

2. Who is climbing the walls? (6)

3. Who was in the vanguard talking about vans? (6)

4. Who was inundated with AI articles (hint: before my time)? (3,4)

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5. What did employee pressure get scrapped? (8)

(Answers to last month's: Field, Hayato, Russell, Crispin, Axelrod)



New Blood Wanted



THE
OPERATIONAL
RESEARCH
SOCIETY

The Operational Research in the Third Sector (ORiTS) Special Interest Group is seeking new Committee members, both to refresh itself and to provide new ideas. No particular qualifications or depth of experience are required – all are welcome to apply and we value diversity. The time commitment is small (currently three/four meetings a year). All we seek is your enthusiasm.

By way of background: ORiTS is open to anyone with an interest in the subject. It aims to help analysts working in, or with an interest in, third sector organisations to do a better job, ORiTS comprises analysts from both OR and other related disciplines that use similar tools, techniques and approaches. It meets periodically, usually with speakers with specialist knowledge of the sector. These meetings also provide an opportunity to network with others, to exchange experiences and offer mutual support. They are run by a Committee who together organise events by suggesting suitable topics, identifying possible speakers, sourcing venues and helping to publicise meetings.

For further details or to discuss what you might be able to offer, please contact Malcolm Fenby: malcolm.fenby@btinternet.com

PRO BONO

The Pro Bono Steering Group, a group that provides oversight and direction to The OR Society's Pro Bono support to the Third Sector, is also inviting applications from people willing to give some time to shaping and implementing this support. To find out more about this, please contact Ruth Kaufman: ruth.kaufman@btinternet.com.