Cross-Party Group on Science and Technology

Tuesday 14 December 2021, 18:30-20:30

Zoom

Applying Mathematical Sciences: Minutes

1. Attendance & apologies

In attendance:

MSPs: Clare Adamson, SNP (Convener); Brian Whittle, Conservatives.

Non-MSPs: Rachel Norman; Andrew Cairns; Catherine Donnelly; Chris Dent; Amy Wilson; Marian Scott; Andrew White; Jess Enright; Benedict Leimkuhler; John Ball; Allan Colquhoun; William Duncan; Karen Petrie; Robin McLaren; Andrew Mackenzie; Andrew Rylah; Bill Sloan; Ian Strachan; Derek Stewart; Fred Young; Kathleen Hill; Kitty Meeks; Niall Sommerville; Susan Burr; Stuart McKay; Stephanie Webb; Alfie Gaffney.

Apologies

Finlay Carson, Murdo Fraser, Clare Reid, Rebecca Bell, Gavin Gibson Cristina Clopot, William Hardie, Daria Tuhtar

2. Minutes of the previous CPG meeting

The minutes of the previous CPG meeting were accepted by CPG members with no corrections or comments. The acceptance of the minutes was proposed by Karen Petrie and seconded by Brian Whittle.

3. Proposal to broaden the remit of the CPG to encompass the social sciences

The proposal to broaden the scope of the CPG to include the social sciences was approved.

The amendment to the scope of the CPG will be submitted to the Standards, Procedures and Public Appointments Committee.

4. Introduction to Edinburgh Mathematical Society, Professor Rachel Norman, Stirling University, President of the Edinburgh Mathematical Society

Rachel provided an introduction to the [Edinburgh Mathematical Society](#), outlining its aims for the development and promotion of the mathematical sciences, including pure mathematics, applied mathematics, statistics, operational research and data science; working across the UK with other five mathematical learned societies to raise the profile of Mathematics; regular activities include monthly meetings with external speakers hosted by universities, annual popular lectures tying in with Maths Week Scotland; funding school projects via a School Enrichment Fund; funding university projects and a Covid Recovery Fund to support research; a journal and range of prizes for early career researchers, PhD students and an impact prize. The aim of the following presentations was to provide a high-level overview of the range of application of mathematical solutions.

5. Presentations on a range of mathematical science-based applications

A copy of any slides used during the meeting, as well as Professor Chris Dent's script, has been circulated alongside the meeting minutes. For further information on the presentations, please contact the Secretariat.

Professor Andrew Cairns FRSE and Professor Catherine Donnelly, Heriot-Watt University, presenting on *Actuarial and Financial Maths*
- Andrew's portion of the presentation covered: the interdisciplinary scope of actuaries work; the need to ensure impact for wider society such as insurance and pensions; mortality longevity risk (at the institutional and individual level); the impact of decreasing mortality rates on pension funds and life insurers; uncertainty around central forecasts; the development of a model to measure uncertainty around forecasts of future mortality improvements; mortality and health inequalities using data from the Office of National Statistics to develop a customised index for mortality inequalities (at the scale of small neighbourhoods, ~1000-2000 people, equivalent to Scottish Data Zones) to improve on the (Scottish) Index of Multiple Deprivation, informed socio-economic factors in relation to cause of death data (controllable factors such as smoking); accounting for regional variation; generating impact through discussions with the Westminster APPG on Longevity and US Gov.

Accountability Office, with plans to extend to Scotland; the LIFE app which allows users to explore the index.

- Catherine's portion of the presentation covered: retirement income choices; conventional pension options such as income drawdown and life annuity; research on new structures, underpinned by longevity risk sharing (whereby the shorter lived subsidise the longer lived, upon death, money is shared to others in the fund who are alive), to produce other options to suit people's risk appetite; an overview of the UK pension situation following the introduction of automatic enrolment via an opt-out scheme; defined contribution pension plans and difficulties converting this into an income at retirement age; proposal for longevity risk sharing structures as a potential new option to allow individuals to decide how much longevity risk and investment risk they want to bear, e.g. via a pooled annuity fund; enabling retirees to live with a better quality of life.

Professor Chris Dent and Dr Amy Wilson, University of Edinburgh, presenting on *Maths and Energy.*

- Chris' portion of the presentation covered: climate change and the importance of energy security; insecurity of supply analysis and dealing with infrequent extreme events using conventional data-driven statistical approaches; contending with limited data on such extremes; supporting electricity capacity procurement decisions; considering the possibility of classes of extreme events; investigating future events and managing uncertainty in forward projections via decision support analysis; climate change and the need for future projections in the context of complex systems; how to clarify the link between climate models and the real world by assessing the uncertainty associated with future projections and support resilience and adaptation decisions, and informing the design of future climate models; the increased prominence of general questions around the use of models and data during the Covid-19 pandemic.
- Amy's portion of the presentation covered: statistical approaches to security of supply analyses, centred around the risk of not having enough generating capacity in relation to electricity demand; the importance of effective risk assessment and decision support; understanding the risks that are conditional on the current state of knowledge and how to take decisions based on this risk assessment; developing statistical models to compute risk measures about security of supply e.g., the expected number of hours without capacity to meet demand and the expected amount of energy that is not met; how modelling is difficult as risk estimates are based on a small number of data points; statistical methods based on Extreme Value Theory can be used to smooth data at extreme points and ensure that any estimates made are less sensitive to data fluctuations; Extreme Value Theory has also been applied to the modelling of interconnection between systems, where the problem of not having enough data is more pronounced; contending with multiple variables, such as solar power, wind generation, battery storage limitations, all of which introduce further uncertainty and complexity; these variable are interconnected, e.g.,

contending with cold and still days (cold = high demand; still = wind is low, which implies a dependency between the two); measuring variables together through more advanced statistical methods; re-scaling historic data to use in statistical models to assess risk for future years; dealing with the uncertainty that re-scaling introduces (e.g. building in the impact of climate change, behaviour change); crucial need to reflect lack of knowledge in any decisions made (e.g. on capacity payments) by accounting for uncertainty and propagating this through into final results; many issues in security of supply analyses are common across multiple different applications, such as forensic science (when accounting for uncertainty in decision-making).

Professor Marian Scott FRSE, University of Glasgow, presenting on *Environmental Statistics*

- Marian's presentation covered: priorities for environmental statistics following COP26, including reaching net-zero emissions; reversing biodiversity; protecting ecosystems; increasing resilience; the data deluge as enabling earth observation, new distributed sensors, and citizen science; links to the Sustainable Development Goals; statisticians' contributions post-COP26 and contributing to modelling to monitor scenarios and develop future projections (underpinned by uncertainty); quantifying our carbon budget and any progress towards net-zero; Biodiversity, CBD 2022, and monitoring programmes; water abstraction near Arbroath using sensors and satellites to understand water resource usage, and instrument a rural catchment in Scotland (challenges included data communication, data quality assurance, fusion of misaligned data streams, cloud cover in Scotland). Statistical modelling improved intelligence about water use and improved water abstraction management practices amongst farmers, helping to mitigate against drought events; statistical modelling enabled an understanding of where to place sensors, what happens in areas without sensors, and to content with uncertainty; enabled details records of diffuse pollution in rivers; Environmental analytics enables inference, innovation, and impact (whilst respecting the complexity/interconnectivity of our urban/rural ecosystems).

Professor Andrew White, Heriot-Watt University, presenting on *Mathematical modelling for species conservation: protecting red squirrels in Scotland*

- Andrew's presentation covered: how mathematical modelling can enable conservation and disease management in wildlife population dynamics; grey squirrels carry a virus which leads to Squirrelpox (with high mortality in red squirrels), first detected Squirrelpox (SQPV) in Scotland in 2006; developing a model to understand the spread across Scotland and impact on remaining populations; using digital habit records, densities of squirrel populations; probabilistic models of red-grey-Squirrelpox dynamics; enabled prediction of rapid spread in Southern Scotland, but slower spread further North; model of percentage chance/risk of SQPV spread revealed that it is unlikely to spread through grey-only squirrel populations that persist in large conifer plantations; results have directly influenced policy (Scottish Strategy for Red Squirrel

Conservation) and practice (protecting red squirrels in Priority Areas for conservation); mathematical modelling adds scientific underpinning rationale, essential to increasing public confidence in conservation policy; impact of forestry/land management on red squirrel pop. dynamics.

Dr Jess Enright, Glasgow University, presenting on *Scotland's contribution to covid modelling*

- Jess' presentation covered: the highlight collaborative role of the Scottish research community throughout the pandemic (between universities, industry, civil service, research institutions); interdisciplinary innovation across Scotland; inferring parameters in disease models via stochastic compartmental models to inform decision-making, rates of moving from susceptible to covid, through to death; using mathematical inference to enable better understanding of rates of spreading in different age categories; mapping wastewater networks to detect Covid in wastewater and use it as a warning system in addition to individual testing; combines statistics (sampling computations) with computer science (network modelling of sewage dynamics).

Professor Benedict Leimkuhler FRSE, presenting on '*Core' Mathematics: foundations for reliable prediction in a chaotic age*

- Ben's presentation covered: the Independent Review of Knowledge Exchange in the Mathematical Sciences (House of Lords report); addressing challenges such as training/communication barriers/recruitment; importance of increasing youth representation; encouraging UK companies to incorporate advanced mathematics in produce development; the need for a ramp-up in funding; proposals for a National Academy of Mathematics; challenge of increasing the accessibility of mathematics work and working with industry/government/NGOs to address the most relevant problems; the Mathematics Centre for Doctoral Training in Mathematical Modelling, Analysis & Computation (MAC-MIGS); partnerships with 40 companies and agencies; projects include inference of ocean dynamical properties, efficient risk estimation, epidemiological modelling, optimal control of power storage, and network science algorithms for the social sciences; importance of critical infrastructure (e.g. Bayes Centre) and a critical mass to maximise success and support the breadth of mathematics across a range of applications.

6. Discussion session

Following the presentations from the speakers, a discussion session was held. The following topics were discussed: engaging and inspiring young people; demonstrating the range of issues to which mathematical science is relevant; increasing mathematical literacy; how modelling has underpinned Covid briefings and COP26, introducing people to modelling; widening participation and inclusivity in mathematics and overcoming the 'pump priming' problem; overcoming reductionist modelling of

food systems to enable multi-dimensional complex understandings; embracing complex, interlinked systems to overcome siloed working practices; interdisciplinary applications of mathematics; how organisational structures in the research community can be tweaked to improve responses to societal crises; the international reputation of Scottish Mathematics and how to support both pure and applied mathematics; the importance of innovation in 'peacetime'; how applied mathematics solutions can be developed by 'pure' mathematicians who support the transfer of knowledge to other subjects; embracing the opportunities provided by Maths pooling initiatives.

The following article, written by Prof. Chris Dent was shared: *Data, algorithms and the 2020 SQA national assessment results*: https://centreforstatistics.maths.ed.ac.uk/cfs/news/data-algorithms-and-the-2020-national-assessment.

7. Dates and themes for future meetings

It was agreed that a date for the next meeting of the CPG will be set in the New Year. It was noted that the next CPG meeting is likely to be virtual.

Possible future themes that were proposed include the Scottish Government Innovation Strategy, and the legacy of COP26.

Any further proposals for future themes would be welcomed. These can be submitted in writing to Alfie Gaffney, CPG Secretariat, at agaffney@rse.org.uk.

8. AOB

There was no additional business discussed.