Australasian Bayesian Network Modelling Society

Newsletter August 2019

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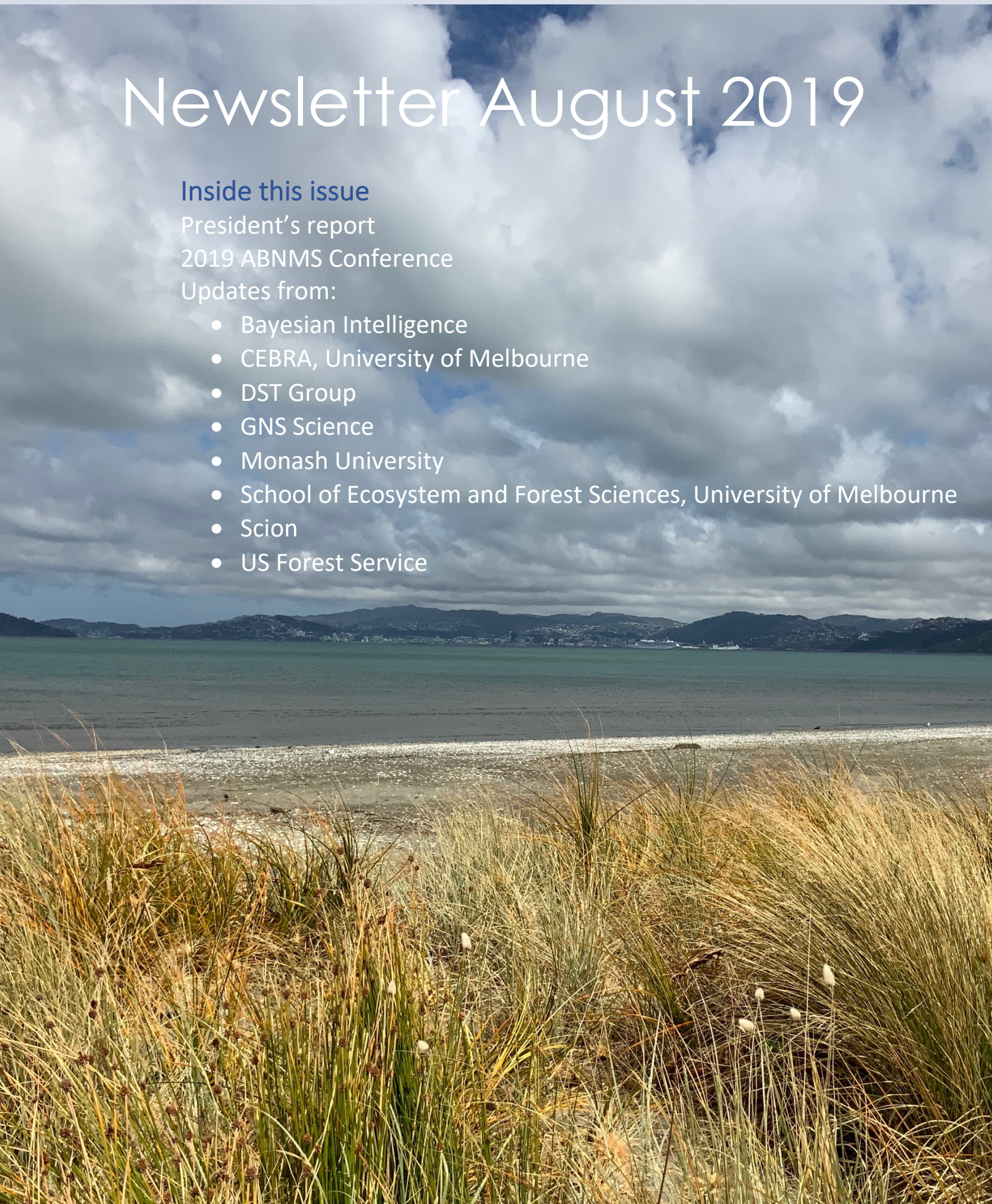

President's report

The Australasian Bayesian Network Modelling Society (ABNMS) started in 2009 with the goal of 'promoting the understanding and use of Bayesian network (BN) models in scientific, industrial and research applications'. Additional goals of 'furthering education and training in BN technology' and 'providing opportunities for BN modellers to exchange ideas and socialize together' have been well-served by the annual conferences, mostly preceded by a two-day tutorial. Over recent years, ABNMS has had a steady membership of about 55.

The annual conferences are one of the main activities of the society. They are usually organised by the president and attended by around 50 members and non-members. ABNMS maintains a website (www.abnms.org) that includes a repository of Bayesian networks. The ABNMS newsletter provides an overview of recent applications of BNs by members and their institutions. The newsletter is usually published once a year but we have not had one for the past two years. Going forward, the society is exploring holding webinars for BN researchers and practitioners to connect more regularly throughout the year.

In 2017, under the presidency of Trent Penman of the University of Melbourne, ABNMS had a joint conference with the Society for Risk Analysis Australia New Zealand (SRA-ANZ) at the University of Melbourne with about twice as many participants (around 100) than in other years. The theme of the conference was 'Risk in an interconnected world'. Prof. Mark Burgman and Dr Bruce Marcot presented keynote lectures on behalf of SRA-ANZ and ABNMS, respectively.

The 2018 conference was partnered with the Australian Defence Science and Technology (DST) group with Andrew Coutts (DST) as president. It was held at the University of Adelaide. We enjoyed three thought-provoking key-note lectures, by Dr Bruce Marcot, Dr Darryn Reid and Victoria Hemmings. We also, for the first time, had panel discussions, one on BNs in general and one on expert judgement. This new format led to lively and at times provocative exchanges with the audience, so the society is keen to explore further topics in this format. We also trialled mini-workshops for those beginning or in the throes of a BN modelling project, wanting to present their work in an informal setting for discussion, feedback and hands-on advice. Again, the experience was positive and there is an appetite for further developing this format.

The 2019 conference will again be held jointly with SRA-ANZ and in partnership with Victoria University of Wellington with the theme 'Risk and Decision-making: How different elements of risk underpin responsible and culturally-appropriate decisions'. This is the second time an ABNMS conference will be held in New Zealand, following the successful 2014 meeting in Rotorua led by Steven Pawson of Scion.

The 2014 conference was my first introduction to ABNMS. I was impressed by the diverse audience, having representation from all New Zealand crown research institutes, some ministries and several universities. With my co-organiser, the president of SRA-ANZ, Lee

Bailey, we hope to attract a similarly broad audience to Wellington and contribute to the ABNMS goal of promoting the understanding and applications of BNs for many varied domains.

Please join us in Wellington!

Kind regards,

Annemarie Christophersen
President of ABNMS in 2019
Hazard and Risk Scientist
GNS Science, New Zealand

Contact ABNMS

Administrative

The administrative contact for the Australasian Bayesian Network Modelling Society can be reached on the following email address: contact@abnms.org

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	Prof Ann Nicholson	ann.nicholson@monash.edu	Monash University

Eleventh Annual Conference of the Australasian Bayesian Network Modelling Society (ABNMS2019)

The ABNMS 2019 conference will be held jointly with the Society for Risk Analysis - Australia and New Zealand and the Victoria Business School of Victoria University of Wellington on 13-14 November. The conference theme is risk and decision-making: How different aspects of risk underpin responsible and culturally-appropriate decision-making.

The theme of the meeting reflects on the different aspects of risks that our individual societies have addressed in the past and plays on the conference location in Wellington, the capital and centre of government for New Zealand. However, we will address more than governmental decision-making. We aim to bring together researchers, consultants, regulators, and policy-makers to discuss how different aspects of risk analysis underpin responsible decision-making. Weaving in Mātauranga Māori and other First Nation knowledge improves the culturally-appropriateness of these decisions.

Risks and their management are an integral part of our lives in the 21st century. Identifying and assessing risks and their uncertainties is paramount for organisations and governments (from local to international) to be able to incorporate these risks into policies and decision-making to protect people, the environment and the economy. The Scientific Programme includes various topic streams, spanning Natural Hazards under a Changing Climate, Biosecurity, Chemical Management, Organisations and Governance, and Health.

ABNMS is honoured to welcome Prof Marek Druzdzek as keynote speaker. Marek is a professor in the School of Computing and Information and in the Intelligent Systems Program and the director of the Decision Systems Laboratory at the University of Pittsburgh. He holds a joint appointment as a visiting professor in the Computer Science Department, Bialystok University of Technology, Poland. Marek will talk about Bayesian Networks in Risk Modelling and Decision Making.

Prior to the conference, the ABNMS offers a two-day training course "Introduction to Bayesian Network Modelling". In addition, Victoria Business School will run a research students' seminar on 12 November and a Theory of Constraints workshop on Friday 15 November. Further workshops will be run by the SRA-ANZ on 15 November.

The call for abstract is open now. Details are available on the conference website :

www.gns.cri.nz/risk-conf-2019 and on http://www.abnms.org/conferences.php.

We gratefully acknowledge sponsorship from the following organisations:

- Bayesian Intelligence for running the ABNMS tutorial
- CEBRA for financial support
- GNS Science for in-kind administrative support such as hosting the website
- Victoria Business School, Wellington, for providing free use of the conference and workshop venues.

For further sponsoring opportunities please contact the local conference organisers on risk-conf-2019 at gns.cri.nz.

We are looking forward to welcoming you in Wellington in November.

This article was contributed by Annemarie Christophersen, President, ABNMS

News and updates

This section features updates from some of our members and their organisations.

Bayesian Intelligence

Bayesian Intelligence is a consulting company that specialises in providing consulting, training, model development and software for Bayesian networks.

Several new and existing projects are keeping us busy at Bayesian Intelligence. Biosecurity in particular has become a larger focus for us in recent years, alongside projects in health, environment and defence.

Our work in biosecurity has been in collaboration with organisations from both New Zealand and Australia. In conjunction with the New Zealand Ministry of Primary Industries and Plant & Food Research, we have been developing a dynamic and spatial model for import risk assessments to handle an array of different pests and import items. The model examines the full pathway, from import to exposure, establishment and spread, along with costs and consequences. We are also developing a more specialised model for Plant Health Australia that focuses on forest biosecurity, that will inform how surveillance resources can be allocated to protect forests and plantations across Australia. This builds on a very similar project that we developed for New Zealand's forestry industry, which became operational last year, and that we are now continuing to develop and improve.

We have been working with the TelethonKids Institute in Perth to develop a model of pulmonary exacerbations for children with cystic fibrosis. The goal of the project's current

stage is to capture existing clinician understanding about exacerbation episodes, including causes, impacts, and approaches to management. It is hoped that the model will provide insight into a Bayesian adaptive trial currently being conducted for management of exacerbations, and will be updated as data becomes available. Ultimately, it is hoped that the model and its derivatives will serve as the basis of decision support tools to assist with CF management. We also have a range of projects that we will be collaborating on over the next couple of years, including projects focusing on bone joint, urinary tract and respiratory infections and vaccination attitudes.

Tools

In the course of our consulting work, we've had cause to create and contribute to a few different general purpose software tools to help us out along the way. We've been looking at ways to make some of these tools more generally available, including two which are freely available via our website.

One of the primary difficulties with building discrete Bayesian networks is specifying the parameters. In the course of our work, we've developed an interpolation tool to help us specify parameters more simply for some of the more common types of relationship. The approach is quite flexible, and can be used in conjunction with decision trees and general formulas to generate a representative conditional probability table more easily. Testing that we have conducted with others (and that we hope to publish soon) has shown that the approach works quite well to recreate expert intentions on both binary and ordinal nodes. The tool is still in development, but is available to use today in beta form via our website: https://bayesian-intelligence.com/interpolator/. We are keen to explore ways in which we can develop the tool further, so please get in contact with us (via bi@bayesian-intelligence.com) if you have an application in mind.

CaMML is a machine learner that learns BNs using a search and score approach (with Minimum Message Length, MML, as the score) that frequently performs better than constraint-based approaches like the PC algorithm. CaMML is an open-source project that is developed by students and staff at Monash and Bayesian Intelligence has contributed some improvements to CaMML as well. We offer a free user-friendly distributable version of the software (known as BI-CaMML) via our website: https://bayesian-intelligence.com/software/camml/.

Other general purpose tools include BayesWatch, an anomaly detection tool for track and movement data; and Bayesian Delphi, a tool for eliciting information from groups of experts using the Delphi protocol. Bayesian Delphi has a survey-style interface, best suited to answering specific modelling gaps. For an end-to-end approach to building BNs with expert groups, we'd recommend Monash's BARD tool, another project that all of us here at Bayesian Intelligence have been heavily involved in over the past few years.

Training

Bayesian Intelligence has held several training workshops this year, both in Australia and New Zealand. We are still finalising details for our next workshops, but they are likely to be held in Melbourne in October.

If you would like to register your interest for upcoming workshops or find out more information, please visit:

https://bayesian-intelligence.com/training/

We are also able to run training for groups and organisations on demand. If interested, please contact Owen Woodberry at training@bayesian-intelligence.com or on +61 0406 924 446.

This article was contributed by Steven Mascaro, Director and Senior Consultant, Bayesian Intelligence

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CEBRA University of Melbourne

The Centre of Excellence for Biosecurity Risk Analysis (CEBRA) has recently been involved in two projects that have made interesting use of BNs and expert judgement.

A risk-based management model for existing pathogens of concern for shellfish aquaculture in New Zealand

Cawthron Institute (New Zealand) in collaboration with CEBRA are aiming to quantify the risk of spread of the parasite *Bonamia ostreae* at a local, regional and national scale, and hence to quantify the risk of spread from the currently infected areas to uninfected populations under different scenarios (e.g. aquaculture being or not being undertaken, mitigation measures being or not being in place). An initial model proposed for this case study is the first step towards achieving the main goal. This first model is a Bayesian network that focuses on small-scale effects at the Marlborough Sounds scale. The BN will later be integrated into a larger body of work, including hydrodynamic models, regional and national scale network models. The BN model will be quantified with a combination of data and expert elicited distributions and correlations. The IDEA protocol for structured expert judgement was used in its hybrid (remote and face-to-face) form to elicit information about more than 100 parameters.

Significant River Red Gum trees in Riverine Forests

Researchers form CEBRA, CEER, SEFS, DELWP, Parks Victoria and Yorta Yorta Nations Aboriginal Corporation collaborated to quantify and evaluate the effectiveness of planned burning mitigation measures, for the protection of habitat, hollow-bearing and culturally significant River Red Gum trees in Riverine Forests.

The project proposed a structured decision making (SDM) framework to aid logical and transparent decision making. SDM places knowledge acquisition squarely in the context of management. It asks if and how we would manage differently if we were unencumbered by scientific uncertainty. Although uncertainties may be pervasive, in many circumstances they may have little influence on what levers we would choose to pull in managing ecosystems and their associated values. In the case where uncertainty does impede decision making, we can think about how targeted monitoring can help to resolve uncertainty to improve decisions

and inform management. A pilot monitoring program and a draft quantitative process model to support evaluation of the monitoring program was proposed. The quantitative model was represented by a BN built and quantified using expert elicitation.

This article was contributed by Anca Hanea, Senior Research Fellow, CEBRA

DST Group

The Defence, Science and Technology (DST) Group provides the Australian Government with scientific advice and innovative technologies to meet Australia's Defence and national security challenges. Our scientists have been investigating the application of Bayesian Networks and statistical techniques for more than 20 years, including areas as diverse as naval warfare, target representation, detecting disease outbreaks, anomaly detection and risk assessments for power generation. More recently, in collaboration with other partners, DST Group scientists applied Bayesian statistics to the international search for the MH370.
Current Bayesian network research areas include the analysis of land combat systems, combat simulations, ongoing anomaly detection research and qualitative Bayesian networks. Some specific projects are:

- Combined BN and Multi-Criteria Decision Analysis (MCDA) methodology for ranking and selecting the best Land Combat Vehicle (LCV): A collaborative PhD research project with Monash University
- BN meta-model for causal and decision analysis of combat simulation
- BN, MCDA, optimisation and fuzzy-logic for multi-scale force effectiveness modelling and defence decision making: A Modelling Complex Warfighting (MCW) Strategic Research Investment (SRI) collaborative research project with Deakin University
- Development of Qualitative Bayesian Networks to provide a means for rapid knowledge capture and representation within Wargaming activities.

For any further information or enquiries on Bayesian network research in DST Group, please contact Dr. Andrew Coutts (Andrew.coutts@dst.defence.gov.au) or Dr. Thang Cao (Thang.cao@dst.defence.gov.au) .

This article was contributed by Andrew Coutts, Group Leader Red Teaming and Wargaming, DST Group

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GNS Science

GNS Science is a Crown research institute and New Zealand's leading provider of earth, geoscience and isotope research and related consultancy services. At GNS Science, a group of us started exploring Bayesian Networks (BNs) within the context of developing risk assessment methods for carbon capture and storage [1,2]. We found BNs to be useful framework to work with colleagues from different sub-disciplines to share their domain

specific knowledge and advance the understanding of complex systems. Subsequently, we developed a pilot model for volcanic eruption forecasting by adapting a related and previously published discrete BN to one of the New Zealand active volcanoes [3]. We simplified each node to have only two states. To better reflect the continuous nature of most volcanic observables we have since started to work with continuous BNs within UniNet [4]. We had the opportunity to do another pilot study to model ice-sheet stability, also using continuous variables within UniNet [5,6]. In our Strategic Science Investment Fund in Hazard and Risk, we have some funding for the coming years to develop decision-support tools using BNs over the coming years. Hosting the conference in Wellington in November 2019 provides us with the opportunity to make BNs better known among our colleagues in earth sciences and climate change.

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6. Christophersen, A.; Keller, E.D.; Hanea A.M.; Golledge, N.; Bertler, N.; Levy, R. and McKay.R. (2018) A continuous pilot Bayesian network to model Antarctic ice sheets. Oral presentation at the Australasian Bayesian Network Modelling Society conference, Adelaide, Australia, 4-5 December 2018.

This article was contributed by Annemarie Christophersen, Team Leader Earthquake Physics and Statistics, Hazards and Risk Scientist, GNS Science

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Monash University

There is a lot of research on Bayesian Networks (BNs) happening at Monash at the moment. Some of the highlights include Kevin Korb work on causal Bayesian networks with a view to elaborating the theory of causal information and applying it in a variety of contexts. Amongst other possible applications, he expects to be using it to analyse philosophical accounts of

causal attribution, causal attribution in legal analysis and causal attribution of extreme weather events. Ingrid Zukerman, together with Matthieu Herrmann and Adul Khan, work on an Natural Language Grammar module that explains the reasoning of a BN: (1) summary explanation, (2) description of BN structure, (3) table of prior and posterior probabilities, and (4) detailed reasoning steps. Also, Ann Nicholson and David Albrecht, together with Julia Flores, have been investigating structure sensitivity analysis of BNs.

Moreover, we have a number of students conducting research on BNs as part of their PhDs. Md Samiullah has developed a full-fledged framework that provides fully defined inheritance for Object Oriented Bayesian Networks (OOBNs). It allows modelling using an inheritance hierarchy of classes, sub-classes, and abstract classes and has been implemented in Hugin. He has also developed an incremental compilation technique that reuses existing compiled Junction Trees of both embedded components and super-classes, and does not require flattening the OOBN. Abida Shahzad research project is on the development of a methodology to handle dependent uncertainties in Multi-Criteria Decision Analysis (MCDA) problems and to compare decision options based on criteria distributions and weight distributions representing the unknown, partly known, and potentially conflicting preferences of decision makers. Finally, Xuhui Zhang research is on extending a casual discovery algorithm to learn structures of BNs with latent variables.

This article was contributed by David Albrecht, Senior Lecturer, Data Science & AI, Monash University

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School of Ecosystem and Forest Sciences, University of Melbourne

The Bushfire Behaviour and Management Group (www.bushfirebehaviour.net.au) in the School of Ecosystems and Forest Sciences at the University of Melbourne has continued to expand the fire risk management work using Bayesian Networks. Our projects continue to focus on the central question of investment in fire management to protect human and environmental assets. Our work involves a range of fire and land managers in south-eastern Australia to ensure that the methods and results are usable.

One of the major projects is a Bushfire and Natural Hazards CRC project in conjunction with the University of Wollongong and Western Sydney University that asks – is there a one size fits all solution to prescribed burning? Prescribed burning is a controversial process and has featured heavily in Royal Commissions following major wildfires since 1939. In this study prescribed burning management scenarios in various bio-regions throughout south-eastern Australia were tested using the PHOENIX RapidFire fire simulator. The results from these simulations are then used to assess the impact on various assets within a Bayesian Decision Network. Results so far suggest the effectiveness of prescribed burning varies between bioregions and is dependent on various factors such as climatic differences and the landscape arrangement of natural and built environments. Some early findings can be found in the following journal articles:
http://www.publish.csiro.au/wf/WF18135
http://www.publish.csiro.au/wf/WF18128

Another area we have had significant success in is looking at fire management to protect and enhance threatened koala populations. Once widespread throughout the southern tablelands of NSW, koalas have undergone significant population declines in this region as a result of habit loss, vehicle collisions and changing fire regimes. Land and fire managers are faced with the challenge of implementing management strategies that reduce the risk of extinction to threatened or vulnerable species such as the koala, while simultaneously reducing the risk to people and property. In this study Bayesian Network modelling was used to assess the value of various management practices for reducing fire risk to koala populations. We examined the trade-offs between a range of fire management scenarios proposed by local land managers. The results from this study identify a series of potential management actions that may reduce the risk of fire to koala populations, without increasing the risk to people, property and other key assets. Results will be used to guide future fire management planning in the region, taking into account both human and ecological assets.

This article was contributed by Kate Parkins, Bushfire Risk Analyst, School of Ecosystem and Forest Sciences, University of Melbourne.

Scion

Biological control risk prediction

Scion is a New Zealand Crown research institute and specialises in research, science and technology development for the forestry, wood product, wood-derived materials, and other biomaterial sectors. In collaboration with partners within the Better Border Biosecurity (B3) partnership and the United States Department of Agriculture – Forest Service, Scion and Bayesian Intelligence are developing a Bayesian network (BN) model assessing the unwanted impacts of biological control agents proposed for release in New Zealand.

Biological control (in its classic form) refers to the control of unwanted pests or weeds using imported natural enemies. It is generally expected that introduced biological control agents will permanently establish in the introduction area and effectively control the target organisms. It is also anticipated that these agents will be specific enough to have no or very little impact on native or otherwise valuable species. In a context of increasing recognition of biodiversity decline, however, providing increased assurance about the specificity of proposed natural enemies has become a critical requirement.

In New Zealand, the Environmental Protection Authority (EPA) assesses the potential benefits and risks associated with the releases of biocontrol agents. This is generally achieved by the examination of available information on the species fundamental host range (generally from laboratory tests), coupled with advice collected from experts and other parties. The new Biological control risk prediction BN model and framework aim to support the EPA by meaningfully and transparently evaluating the ecological host range and impacts of an introduced natural enemy. As compared to other frameworks, it considers a wider range of key biological and ecological factors affecting the likelihood of an introduced agent affecting a non-target species. Notably it incorporates interactions such as species encounters across

natural and agricultural habitats (given their distribution and mobility) and the conditional outcomes of these encounters (given the natural enemy's attacking behaviour).

Bruce Marcot

Dr Bruce Marcot (USDA-Forest Service), will attend the ABNMS 2019 with support from the Agricultural and Marketing Research and Development Trust (AGMARDT). Dr Marcot's talk will feed in the conference Biosecurity stream, providing an overview of the use of BNs and related modelling approaches for the management of invasive and potentially injurious organisms in complex ecosystems. During his visit in Wellington, a seminar will also be organised to key government agencies that are responsible for managing New Zealand's agricultural capital and biological heritage.

An additional workshop is planned in Rotorua to work with Scion and partners on the Biocontrol risk prediction model and on the initial design of a model to predict the spread, latency and detrimental effects of kauri dieback.

Dr Marcot's visit planned for 2019 will be followed by another visit to New Zealand in 2020 to promote innovative risk management solutions for recently introduced pests or pathogens, including auxiliary species intended for intentional introduction (e.g. in a biological control context).

This article was contributed by Nicolas Meurisse, Forest Entomologist, Scion

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US Forest Service

EMDS has a GeNIe with a SMILE

The Ecosystem Management Decision Support (EMDS) system has been serving the needs of natural resource land managers in the United States and beyond for a number of years now (Reynolds et al. 2014). First released in 1997, and recently updated to Version 7, EMDS is a freely-available, spatial decision support framework, composed of a suite of analytical engines tied to geographic information systems (GIS) to help researchers and managers evaluate landscape conditions for strategic and tactical planning. The classical notion of a decision support system includes a "problem processing system" that reads and interprets data to draw conclusions and perhaps make recommendations to a system user (Holsapple 2003). A shorter alternative name for a problem processing system is an engine. GIS analysts often use simple overlay operations to analyze how data affect some outcome of interest (e.g., habitat suitability), but overlays are, in effect, extremely simplistic models, whereas engines can process deep, complex knowledge captured in various kinds of models (e.g., logic or Bayesian models).

EMDS is essentially a spatially-referenced decision support system that can integrate empirical data, geographic information, and knowledge-based reasoning. Its analytical engines include a fuzzy logic engine (NetWeaver), multi-criteria decision analysis (Criterium DecisionPlus, CDP), Prolog-based decision trees (VisiRule) ... and now Bayesian networks (BNs).

The BN component is comprised of BayesFusion's SMILE Engine (www.bayesfusion.com). The addition of a BN component is particularly useful for EMDS applications pertaining to the adaptive management element of ecosystem management by explicitly representing degrees and implications of uncertainties. SMILE (standing for Structural Modeling, Inference, and Learning Engine) comes with the GeNIe (standing for Graphical Network Interface) software, an interactive graphical user interface (GUI) for BN application development, written for Windows, but working also under iOS and Linux operating systems.

The GIS component of EMDS runs in ArcMap, QGIS, MapWindow, and DotSpatial, making EMDS a highly flexible system for environmental analysis and planning at any geographic scale (or multiple scales). The EMDS core component manages the interoperability of the analytical engines with each other and the GIS environment, and is built on the open source Windows Workflow Foundation (WWF). A workflow is an organized collection of activities (often, but not necessarily, sequential) that are executed to accomplish some overall analytical task (Chappell 2009). Due to its WWF architecture, EMDS applications can invoke complex sequences of analytical tasks, using any or all of its analysis engines in any order that makes sense to the application at hand. In EMDS version 7, system users can incrementally build a workflow, invoking the engines one at a time, or (and this is the real power of workflows) the task sequencing can be programmed in a graphical workflow editor that is integrated into EMDS. Thus, programmed workflows enable automation. For example, one might run an analysis, and then want to explore 40 alternative scenarios that represent either variations in data inputs or model specifications, or both. This is easily automated in a workflow editor.

Because the focus of this note is the addition of BN processing, the following is an example of a workflow sequence that illustrates how the SMILE Engine might fit into a larger, more complex decision support project for ecosystem restoration (see Figure 1):

1. BNs, created by the user through the GeNIe interface and processed by the SMILE engine, are used to assess population viability of a few to several keystone species.
2. BN outputs are integrated into the biodiversity component of a NetWeaver logic model that evaluates the broader question of ecosystem integrity.
3. NetWeaver outputs (and additional external logistical considerations) are passed to a strategic CDP model that prioritizes landscape elements for restoration activities.
4. Finally, VisiRule could be invoked to recommend optimal tactical management actions in high priority landscape elements.

In this example, SMILE outputs flow through steps 2 to 4, influencing the logic evaluation, and strategic and tactical decisions for ecosystem restoration.

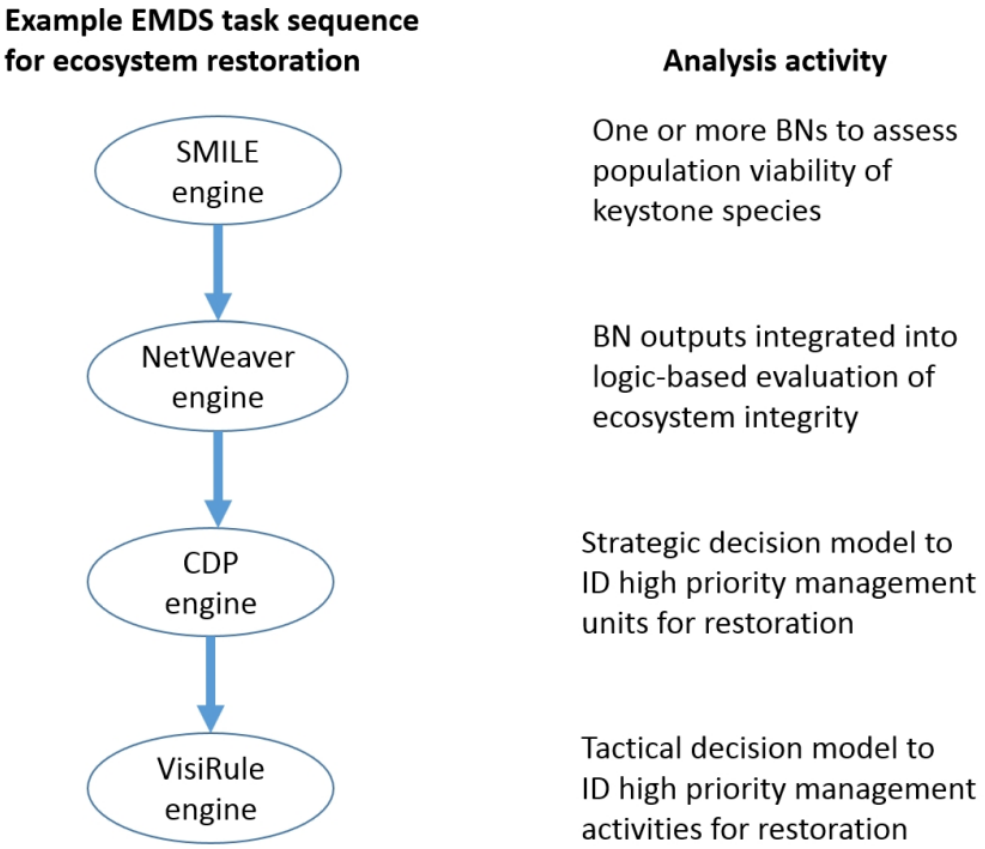

Figure 1. Workflow stream in EMDS using a Bayesian network model

Several applications of the BN component of EMDS are currently proposed for aiding resource management decisions in a GIS environment in the Pacific Northwest, U.S. For example, one application would use a published BN model (Marcot et al. 2019) that determines the potential injuriousness of invasive species. Integrating this model in a GIS framework would produce regional maps showing probabilities of invasive species establishment, spread, and harm among sub-basins (catchments), which could help prioritize locations and guide targeted management activities to dissuade such species introductions.

Many other applications are possible and await development. In EMDS, these BN applications could either be stand-alone, or integrated into a sequence of analytical as described above.

EMDS information and free download can be found at http://emds.mountain-viewgroup.com/. Further information and links to applications can be found at https://en.wikipedia.org/wiki/Ecosystem_Management_Decision_Support.

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Disclaimer: Mention of commercial products does not necessarily entail endorsement by the U.S. Government and U.S. Forest Service.

This article was contributed by Bruce G. Marcot, Research Wildlife Biologist, and Keith M. Reynolds, Research Forester, Pacific Northwest Research Station, U.S. Forest Service