Australasian Bayesian Network Modelling Society

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ABNMS 2016 Conference
22 – 25 November 2016, Perth, Australia

Vineyard, Margaret River

Beach on Rottnest Island

Serpentine Falls

cebra
Centre of Excellence for Biosecurity Risk Analysis

BAYESIAN INTELLIGENCE

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President's Report

The society is now in its seventh year and continues to serve its mission well of promoting practical implementations of Bayesian network technology in science, industry and academia, as well as bringing modellers together to share ideas and to learn from each other.

In 2016, the ABNMS board has focused its efforts on growing the society and strengthening connections with its members. With the generous help of Dr Bruce Marcot, we have reached out to potential friends in North America about establishing a sister society. We hope to see something concrete come from those efforts over the course of the next year. We have also been working on improving the resources available on the ABNMS website. We've improved the forums (abnms.org/forum) and streamlined the login process, which is now integrated with the rest of the site. We've also been working to add many more networks to the ABNMS BN repository (abnms.org/bnrepo). This effort has benefited from a recent agreement with Norsys (norsys.com) to allow the sharing of networks across our two repositories.

Last year's conference at Monash University, Melbourne went very well, with the highest number of attendees for some years. We were fortunate to have three thought-provoking keynotes, given by Assoc Prof Jonathan Keith from Monash University, Dan Ababei from LightTwist Software and the aforementioned Dr Marcot, who made a second appearance that followed up on his very well received keynote from Rotorua. I would like to thank Kevin Korb (2015 president and main conference organiser), the board, those who delivered workshops (including Stefan Conrady from BayesiaLab), along with everyone else involved in making last year's conference a success.

The ABNMS conference visits the west coast of Australia for the first time this year, with the 2016 conference taking place at St Catherine's College, at the University of Western Australia. I would like to thank Vandana Subroy, who has been doing an excellent job helping to organise hosting for the conference this year. As always, the conference will be preceded by a 2 day workshop that provides an overview of Bayesian network concepts and software tools. The workshops are always well attended; we expect this year to be no different, so please book early to ensure your place.

If you are using Bayesian networks in your current projects, or contemplating them for a future project, please do submit an abstract for this year's conference (abnms.org/conferences/abnms2016). We welcome work that is ready for publication, but also encourage submissions on applications that are under development or in the early feasibility and planning stages. As a less formal conference, you can get early feedback on your ideas, designs and plans, and you may find a new collaborator while you're at it!

See you in Perth!

Regards,
Steven Mascaro

ABNMS 2016 Conference

http://www.abnms.org/conferences/abnms2016/

The 2016 ABNMS conference will be held at St Catherine's College, University of Western Australia in Perth from the 22-25th November. The modelling workshops 22-23rd November (venue to be announced) will be followed by the ABNMS Conference on the 24-25th November (Conference Room, St Catherine's College). Accommodation is available at the college itself as well as nearby in the city centre; see our travel and accommodation web page.

Pre-conference BN Tutorials

22 and 23 November 2016

A two-day introduction to Bayesian Networks (BNs) and related technology. Includes an overview of BNs and software platforms, expert elicitation for parameterizing BNs, GIS integration, sensitivity analysis and an introduction to more complex BNs, e.g., object orientated, plus more.....

- Tutors from ABNMS and Bayesian Intelligence Pty Ltd.
- Cost: $100 (member) or $200 (non-member)

ABNMS Conference

24 and 25 November 2016

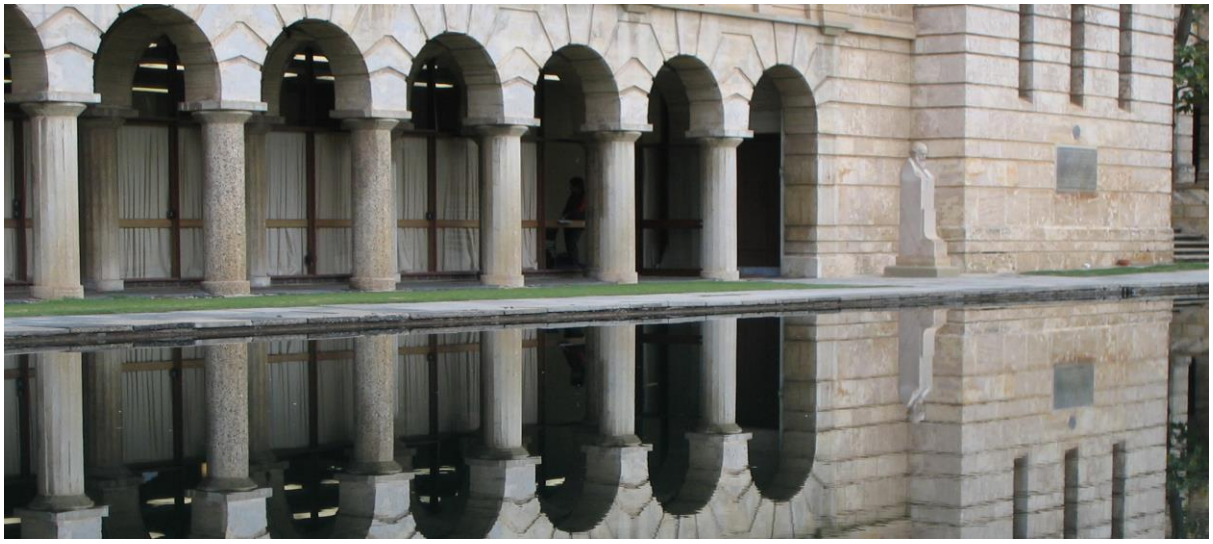
Keynote Speakers

- **Assoc Prof Marek Druzdzel**, BayesFusion and University of Pittsburgh

Abstracts are invited from any area of application or science using Bayesian networks for analysis, modelling, decision making or problem solving. Submissions describing methods and research on Bayesian net technology itself (e.g., tools, interfaces, data mining, Bayesian updating) are likewise encouraged.

- Abstract Submissions Due: 19 Sep 2016
- Registration Deadline: 7 Nov 2016
- Cost: Students: $100; Members: $200; Non-members: $250

See our Call for Abstracts page for more details.

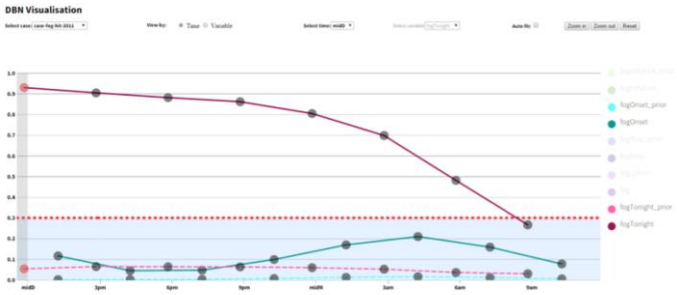


Reflection Pool, University of Western Australia, Photo by Greg O'Beirne

News and Updates

Monash University

Monash continues its active involvement in BN research and development, with researchers: Dr David Albrecht, Dr Kevin Korb, Prof Ann Nicholson (despite acting as Deputy Dean of IT at Monash), Dr Francois Petitjean, and many postgraduate students.



DBN visualisation for fog forecasting

Recent Bayesian network (BN) applications research includes:

- Modeling water reservoirs in Andalucia, Spain using Omnigram Explorer and causal discovery [Ropero, R. F., Nicholson, A. E., & Korb, K. (2015). Using a New Tool to Visualize Environmental Data for Bayesian Network Modelling. In *Conference of the Spanish Association for Artificial Intelligence* (pp. 175-184). Springer.]
- New ways of visualizing dynamic BNs, applied to fog forecasting for the Bureau of Meteorology [Boneh, T., Weymouth, G. T., Newham, P., Potts, R., Bally, J., Nicholson, A. E., & Korb, K. B. (2015). Fog Forecasting for Melbourne Airport Using a Bayesian Decision Network. *Weather and Forecasting, 30,* 1218-1233.]
- Environmental modeling combining GIS and BNs [Chee, Y. E., Wilkinson, L., Nicholson, A. E., Quintana-Ascencio, P. F., Fauth, J. E., Hall, D., Ponzio, K.J. & Rumpff, L. (2016). Modelling spatial and temporal changes with GIS and Spatial and Dynamic Bayesian Networks. *Environmental Modelling & Software, 82*, 108-120.]

Work in progress includes applying online Delphi elicitation methods to structural and parameter BN development. Another new project (with PhD student Md. Samiullah) is developing object-oriented BNs for assisting Bangladeshi farmers in their agricultural decision making, in a joint project with Oxfam.

Methodological research continues on data mining BNs from data, including:

- Learning latent variable structure from the dependency patterns shown by observed variables [Zhang, X., Korb, K. B., Nicholson, A. E., & Mascaro, S. (2016). Latent Variable Discovery Using Dependency Patterns. arXiv preprint arXiv:1607.06617.]
- Learning high-dimensional undirected graphical models [Petitjean, F., & Webb, G. I. (2016, August). Scalable Learning of Graphical Models. In Proceedings of the 22nd ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (pp. 2131-2132). ACM Digital Library.]
- A PhD project of Kelvin Li aims at developing new methods of Markov Blanket discovery for scaling up BN data mining.

BN Research at the Queensland University of Technology

Bayesian network (BN) modelling and research at Queensland University of Technology (QUT) use a variety of BN modelling software and approaches to solve and explore vexing questions and complex systems in health, industry and the environment. Associated with the BN research, we are also very active in expert elicita-

tion, which is an intrinsic part of BN model design, parameterisation and validation, for both data poor and data rich environments. One example of a current project which involves BNs and building on previous research regarding seagrass beds, concerns the wider management of marine ecosystems and is led by Dr Paul Wu.

Photo by Gary Kendrick

Coastal development is a key stressor contributing towards unprecedented declines globally in marine ecosystems including corals, seagrasses and mangroves. Management of these ecosystems is challenging due to the cumulative impacts of biological, environmental and ecological factors and the emergence of non-linear, at-times synergistic responses to stressors. Dynamic Bayesian Networks (DBNs) provide a natural tool for capturing the complex network of interactions and emergent behaviour characteristic of these complex systems. The response trajectories derived from the posterior temporal distributions of the DBN provide insight into risk and resilience of these systems to a range of different stressors, anthropogenic and natural. The research investigates these impacts and methodologies for predicting and better understanding (via data and expert knowledge) the underlying ecosystem processes.

Below is a selection of recent papers that may be of interest:

Health

Sarini, Sarini, McGree, James, White, Nicole, Mengersen, Kerrie, & Kerr, Graham (2015) Comparison of decision tree, support vector machines, and Bayesian network approaches for classification of falls in Parkinson's disease. International Journal of Applied Mathematics and Statistics, 53(6), pp. 145-151.

Industry

Vine, Desley, Buys, Laurie, Lewis, Jim, & Morris, Peter (2016) Application of a Bayesian network complex system model examining the importance of customer-industry engagement to peak electricity demand reduction. Open Journal of Energy Efficiency, 5, pp. 31-47.

Wang, Zhiru, Su, Guofeng, Skitmore, Martin, Chen, Jianguo, Chan, Albert P.C., & Xia, Bo (2015) Human error risk management methodology for rail crack incidents. Urban Rail Transit, 1(4), pp. 257-265.

Environment

Wu, Paul P.Y., Mengersen, Kerrie, McMahon, Kathryn, Kendrick, Gary A., & Caley, M. Julian (2015) Predicting the temporal response of seagrass meadows to dredging using Dynamic Bayesian Networks. In Weber, T., McPhee, M.J., & Anderssen, R.S. (Eds.) MODSIM2015 21st International Congress on Modelling and Simulation : Proceedings, Modelling and Simulation Society of Australia and New Zealand, Gold Coast, Qld.

Johnson, Sandra, Mengersen, Kerrie, Ormsby, Michael, & Whittle, Peter (2015) Using Bayesian networks to model surveillance in complex plant and animal health systems. In Jarrad, Frith, Low-Choy, Samantha, & Mengersen, Kerrie (Eds.) Biosecurity Surveillance - Quantitative Approaches. CABI, Wallingford, Oxenford, United Kingdom, pp. 278-295.

Elicitation

Pirathiban, R., Williams, K.J., Pettitt, A.N., & Low-Choy, S.J. (2015) Eliciting and encoding expert knowledge on variable selection into classical or Bayesian species distribution models. In The International Biometric Society Australasian Region Conference 2015: BIOMETRICS by the Harbour, 30 November - 3 December 2015, Hobart, Tasmania.

Modelling News from the U.S., Dr Bruce G. Marcot

Here in the Pacific Northwest of the U.S., we continue to craft and apply Bayesian networks to a wide variety of projects.

***Wildlife models*:** My colleagues here in the U.S. Forest Service, Pacific Northwest Region (Washington and Oregon states), have built a number of BN models for evaluating viability of terrestrial wildlife species. The models are being actively used for updating land use plans on several national forests in the eastern part of the region, and the intent is to further refine the models for use in other upcoming forest plan updates. (In the U.S., national forests are bound by law and regulation to create and regularly update their multiple-use forest plans.) The modeling methods are published in Suring et al. (2011) and Gaines et al. (in press).

***Models of rarity and uncertainty*:** I am engaged with the Pacific Northwest Regional Office to also develop BN modeling frameworks for evaluating viability of a host of other rare or little-known species of conservation concern -- including fungi, lichens, mosses, vascular plants, insects, and other invertebrates -- occurring on our federal public lands. The "rare or little-known" part of this is the big challenge, and the BN approach fits well to expressly denote uncertainty under the Region's risk assessment and risk management approach to planning (see Marcot 2016).

***Polar bears*:** Other projects recently completed pertain to massively updating a BN model for evaluating potential impacts on global populations of polar bears from human activities, environmental conditions, and climate change impacts on sea ice and seal prey (Atwood et al. 2016). The model has been made available to the U.S. Fish and Wildlife Service who is charged with developing a conservation and recovery plan for the species. Our updated model again highlights the major influence that climate change will have on the species over the 21st century. The model is posted on the ABNMS Repository (abnms.org/bnrepo/bn?bnId=168).

***More bears*:** I also helped develop a novel BN modeling approach for assessment of human recreational impacts on brown bears in Alaska (Fortin et al. 2016). This model was developed for use by managers who face tough decisions about balancing demand for recreational experiences with mandates for preserving the viability of bear populations. This, and the polar bear model, were developed, reviewed, and refined in teams consisting of diverse representations of agencies, academia, and non-government organizations, by using methods of knowledge elicitation from multiple experts. The brown bear model is posted on the ABNMS Repository (abnms.org/bnrepo/bn?bnId=145).

***Pubs in prep*:** Other team-based, BN modeling projects in my current work calendar include publishing a variety models for evaluating: habitat and environmental factors contributing to breeding success of two species of colonial-nesting storks in southern Nepal; habitat suitability of rare, benthic marine species off the U.S. Pacific Coast, for aiding the siting of ocean ener-

gy projects; and occurrence of coastal wetland birds along the U.S. Northeastern Seaboard. Other papers submitted are on models developed with Scion, New Zealand (Steve Pawson) predicting forest insect flight activity; and a decision advisory system for identifying and avoiding importation of invasive and injurious freshwater fish species. Bayesian networks are surely one of the more flexible modeling frameworks around!

***Hot topic reminders*:** Lastly, I'd like to reiterate three "hot topics" still needing (collaborative) research, that I mentioned in my missive in the 2015 ABNMS Newsletter: (1) how to fill in missing values in conditional probability tables (CPTs) constructed from machine-learning algorithms; (2) how to explicitly partition components of variation and uncertainty in network structures, particularly denoting parameter value uncertainty, model structure uncertainty, and measurement error; and (3) how to explicitly depict confidence in CPT values. Any takers?

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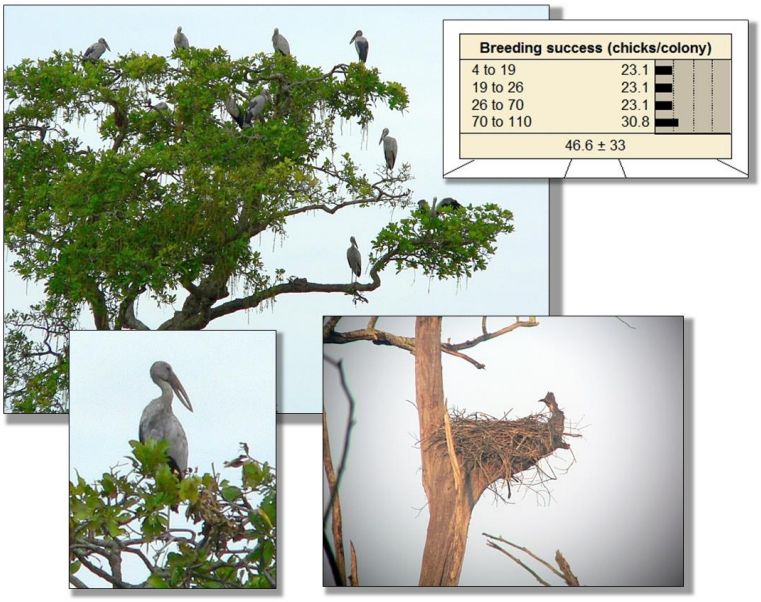
Atwood, T. C., B. G. Marcot, D. C. Douglas, S. C. Amstrup, K. D. Rode, G. M. Durner, and J. F. Bromaghin. 2016. Forecasting the relative influence of anthropogenic stressors on polar bears. Ecosphere 7(6):DOI: 10.1002/ecs2.1370.

Fortin, J. K., K. D. Rode, G. V. Hilderbrand, J. Wilder, S. Farley, C. Jorgensen, and B. G. Marcot. 2016. The impacts of human recreation on brown bears (Ursus arctos): a review and new management tool. PLoS ONE 11(1):e0141983. doi:10.1371/journal.pone.0141983.

Gaines, W. L., B. C. Wales, L. H. Suring, J. S. Begley, K. Mellen-McLean, and S. Mohoric. In press. Terrestrial species viability assessment for the national forests of northeastern Washington. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-xxx.

Marcot, B. G., M. P. Thompson, T. W. Bonnot, and F. R. Thompson. 2016. Uncertainty is information, too. The Wildlife Professional 10(1):30-33.

Suring, L. H., W. L. Gaines, B. C. Wales, K. Mellen-Mclean, J. S. Begley, and S. Mohoric. 2011. Maintaining populations of terrestrial wildlife through land management planning: A case study. Journal of Wildlife Management 75(4):945-958.

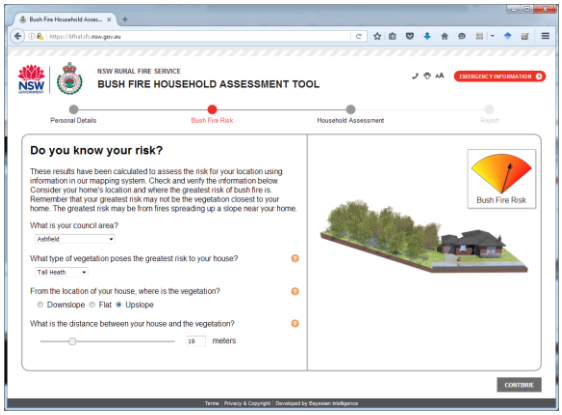


Found in India, Nepal, and parts of southeast Asia is this species of stork, the Asian Openbill. Although not globally threatened, local impacts on colonies from habitat loss and disturbance are poorly known. We are modeling their habitat associations and impacts in an agricultural landscape in lowland Nepal.

Bayesian Intelligence

Bayesian Intelligence has had another fulfilling year, with a diverse array of projects keeping us on our toes.

We have been working on several biosecurity projects with government departments and organisations from both Australia and New Zealand. In New Zealand, we have been working with the Ministry of Primary Industries (MPI) on expanding our prototype model for their forest health surveillance efforts, finalising our market access model for timber exports in collaboration with Scion NZ, as well as continuing to develop a more generally applicable model for all organisms that may threaten New Zealand's biosecurity. In Australia, we have been working on projects for biosecurity in northern Australia and western Australia, and have helped the Department of Agriculture and Water Resources (DAWR) with two tools: a Histopathologist Syndromic Surveillance tool for ornamental fish imports, as well as sensitivity analysis software for the department's Risk Return Resource Allocation model.



The NSW RFS Bush Fire Household Assessment Tool

Earlier this year, the NSW RFS published the Bush Fire Household Assessment Tool (bfhat.rfs.nsw.gov.au). This is based on a model originally created by Trent Penman's group at the University of Wollongong, and has an interface developed by Bayesian Intelligence. The use of Bayesian networks by the general public, whether directly or indirectly, is still quite uncommon, and we are quite pleased with how this application has turned out. The site provides a very user-friendly interface that works on both desktop and mobile browsers. It also tracks the underlying BN very closely. We'd love to hear from people who have tried the tool.

We've also been working on several other projects in the domains of defence, environmental modelling and mining as well as working on Bayesian network visualization and elicitation. We have also run several of our training workshops this year, including both our Introduction to BNs workshop and our API Programming workshop.

Training

BI will be running its two-day **Introduction to Bayesian Networks** workshop in Adelaide in October. This is an excellent opportunity to learn the foundations of Bayesian networks and their common extensions, as well as to network with others who are using the techniques or just starting out.

If you would like to register your interest, please visit the following site:
bayesian-intelligence.com/training/

You can also visit the above site for more information about our workshops or you can contact Steven Mascaro on training@bayesian-intelligence.com or on +61 425 801 277.

Research at GNS Science

At GNS Science we have started using Bayesian networks (BNs) in hazard and risk assessment for carbon capture and storage [1,2]. We found BNs to provide a

useful framework for people from different disciplines to contribute their knowledge in a structured way. Therefore BNs are great tools to address problems that require multi-disciplinary input such as volcano monitoring.

Our volcano monitoring team regularly estimates the probability of forthcoming eruptions for the New Zealand volcanoes that are in a state of unrest. However, the team has no quantitative models that can assist in forecasting future eruptions, and that can support decision-making. We started working with some of the team members to adopt a discrete BN from a published paper to White Island volcano. The model links the not directly observable processes within the volcano that lead to eruption with the monitoring data that are regularly collected. In December 2015 we held an expert elicitation workshop with most of the volcano monitoring team and two external experts to elicit the conditional probability tables. The BN model seems to forecast higher likelihoods for an eruption in the coming month, than experts providing these kind of probabilities without a model. We are now revisiting the nodes of the driving processes with the volcanologists in view of the most recent eruption that happened in April 2016. We have also started to explore continuous BN modelling with Uninet and realise that we would like to move on to a dynamic BN since a volcano is dynamic and forever changing.

1. Gerstenberger, M.C.; Christophersen, A.; Buxton, R.; Nicol, A. 2015.Bi-directional risk assessment in carbon capture and storage with Bayesian Networks. International Journal of Greenhouse Gas Control 35: 150-159.

2. Gerstenberger, M.C.; Christophersen, A. 2016. A Bayesian network and structured expert elicitation for Otway Stage 2C: Detection of injected CO2 in a saline aquifer. International Journal of Greenhouse Gas Control 51: 317-329.

BayesiaLab Introductory Courses

This highly acclaimed course gives you a comprehensive introduction that allows you to employ Bayesian networks for applied research across many fields, such a biostatistics, decision science, econometrics, ecology, marketing science, petrochemistry, sensory research, sociology, just to name a few.

The hallmark of this 3-day course is that every segment on theory is immediately followed by a corresponding practice session using BayesiaLab. Thus, you have the opportunity to implement on your computer what the instructor just presented in his lecture. This includes knowledge modeling, probabilistic reasoning, causal inference, machine learning, probabilistic structural equation models, plus many more examples. Given the strictly limited class size, the instructor is always available to coach you one-on-one as you progress through the exercises.

After the end of the course, you can continue your studies as you will have access to a full 60-day license of BayesiaLab 6 Professional. Additionally, two workbooks, plus numerous datasets and sample networks help you to experiment independently with Bayesian networks.

To date, over 600 researchers from all over the world have taken this course (see testimonials). For most of them, Bayesian networks and BayesiaLab have become crucial tools in their research projects.

To register for our Perth course, please visit:

www.bayesia.com/2016-11-intro-course-perth-wa

Centre of Excellence for Biosecurity Risk Analysis (CEBRA)

CEBRA was established through an agreement between the University of Melbourne, the Australian Federal Department of Agriculture (DA) and the New Zealand Ministry for Primary Industries (MPI). It ensures policy interventions and tools are underpinned by world-class research and understanding of the issues, risks and response mechanisms. CEBRA plays a vital role in ensuring governments remain at the forefront of practical risk assessment through the provision of collaborative, relevant and practical research outcomes.

Below are two recent projects at CEBRA that have made interesting use of BNs and expert judgement.

Predicting pollinator abundance using the IDEA protocol for structured expert judgement

The University of Warwick in collaboration with CEBRA are aiming to provide decision support for pollinator abundance aimed at policymakers wishing to evaluate different policy options available to them. A proof of concept decision support system, based on a BN modelling approach was build and quantified using the structured expert judgement protocol called IDEA. The IDEA protocol has emerged from a considerable stream of research, conducted mostly by CEBRA researchers. In this project 12 experts from academia, industry and government with expertise in pollinators, crops, policy, biosciences, and statistics participated in an elicitation workshop that took place at the University of Warwick. The workshop was facilitated by CEBRA and University of Warwick researchers and it attracted extensive media coverage including a special report on BBC news.

A continuous Bayesian network to forecast White Island volcanic eruptions

CEBRA and GNS Science (NZ) researchers collaborate in building a first continuous BN model that links inaccessible volcanic driving processes with existing monitoring data in order to forecast eruption on White Island (NZ). Limitations of a first discrete BN prototype were identified and will be tackled by constructing its continuous counterpart. Quantifying such a model will require a combination of data and expert judgements. Most volcanic monitoring data are of continuous nature and structured elicitation protocols are available for the data gaps. The experts who participated in quantifying the initial discrete BN expressed their interest in participating in a second workshop for quantifying a continuous model.