

Working Group 2

Dependence Modelling and Elicitation

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MAIN ACHIEVEMENTS

- › STSM
- › WG2 meeting
- › Published systematic literature reviews
 - › Research progress on process and biases
 - › Subject expert opinions to empirical control
 - › Graph specification for BNs

SHORT TERM SCIENTIFIC MISSIONS

- › Christoph Werner (Strathclyde) July 2014.
- › Maria Nogal (Trinity College Dublin) March 2016
- › Alex Kosgodagan (École des Mines de Nantes) October 2016
- › Sophia Wright (Warwick) 2017
- › A number of publications
 - › Published/in press
 - › Accepted
 - › Submitted
 - › Collaboration still going on



Invited Review

Expert judgement for dependence in probabilistic modelling: A systematic literature review and future research directions



Christoph Werner^{a,*}, Tim Bedford^a, Roger M. Cooke^b, Anca M. Hanea^c, Oswaldo Morales-Nápoles^d

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^cCentre of Excellence for Biosecurity Risk Analysis, University of Melbourne, Melbourne, Australia

^dFaculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands

A 2-dimension dynamic Bayesian network for large-scale degradation modelling with an application to a bridges network

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WG2 MEETING WARSAW JUNE 2016

- › Christoph Werner (Scotland)
- › Maria Nogal (Ireland)
- › Daniel Puig (Denmark)
- › Grzegorz Król (Poland)
- › Simona Miraglia (Denmark)
- › Fabrizio Ruggeri (Italy)
- › Oswaldo Morales Napoles (Netherlands)

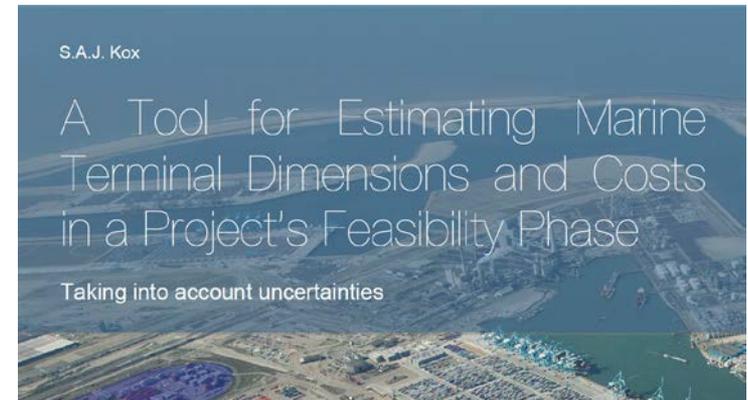


"DEPENDENCE CALIBRATION"

- › Paper(s) submitted
- › 1 recent MSc thesis used both methods
- › 1 application in resilience of traffic networks
- › 1 application (precipitation) assessing asymmetries bivariate distributions

Understanding the vulnerability of traffic networks
by means of structured expert judgment

Calibration and Combination of Experts' Dependence Estimates



ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering

ISSN (online): 2376-7642
Frequency: Quarterly | Sponsored by the Committee on Technical Advancement

Characterization of Precipitation through Copulas and Expert Judgement for Risk Assessment of Infrastructure

Oswaldo Morales-Nápoles¹; Dominik Paprotny²; Daniël Worm³;
Linda Abspoel-Bukman⁴; and Wim Courage⁵

Abstract: In this paper two methodologies are investigated that contribute to better assessment of risks related to extreme rainfall events.

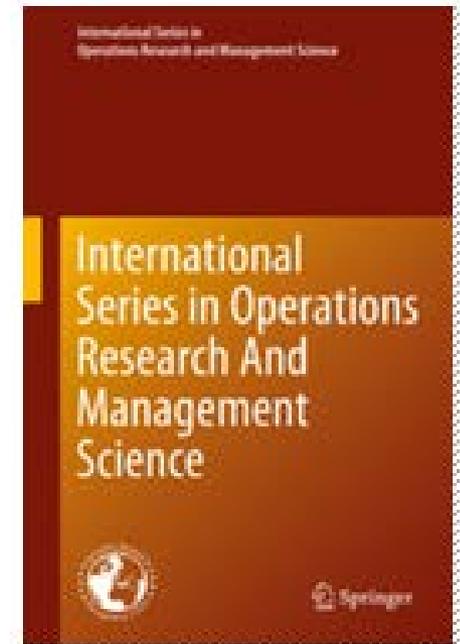
OVERVIEW OF CONSIDERATIONS ALONG EJ PROCESS WHEN ELICITING DEPENDENCE

Book chapter in press (Springer International Series
in OR and MS)

Werner C, et al., Eliciting Multivariate Uncertainty
from Experts: Considerations and Approaches along
the Expert Judgement Process. (Chapter 8)"

Contains:

- Literature review on cognitive fallacies when eliciting dependence
- Overview of dependence elicitation process

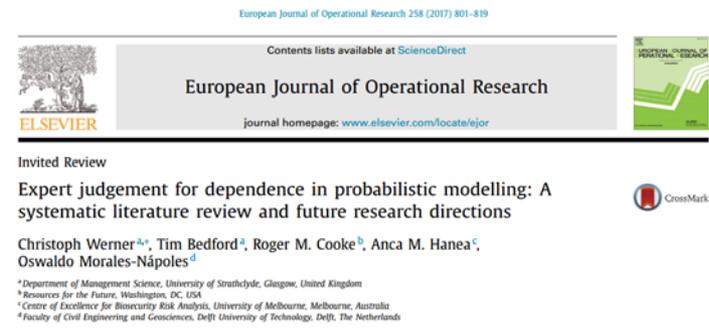


REVIEW ON DEPENDENCE ELICITATION

Published article (EJOR)

Contains:

- Expert judgement methods for various common dependence models (in different modelling contexts)
- Review of commonly elicited forms and their assessment burden



Bias mitigation & structuring experts' knowledge on dependence: Mapping conditional scenarios

- 1 Paper under review
- 1 application in higher education risk assessment (managing portfolio of income streams in HE)
- Further applications planned, e.g. in antibacterial resistance risk assessment
- Extended abstract won Donald Hicks Scholarship from UK OR Society (for presenting at EURO 2016)

Mapping Conditional Scenarios for Knowledge Structuring in
(Tail) Dependence Elicitation



Detailed and feasible assessment of dependence through *sequential refined conditioning*

- 1 Paper to be submitted soon
- 1 application in terrorism risk assessment

The sequential refined conditioning method: addressing under- and overspecification of detailed expert judgement in probabilistic dependence modelling

ITRN.ie

Irish Transport Research Network

IRISH TRANSPORT RESEARCH NETWORK CONFERENCE 2016
Transport Policies For The Future – Learning From The Past
DIT Grangegorman, Dublin, 1st September, 2016

UNDERSTANDING THE VULNERABILITY OF TRAFFIC NETWORKS BY MEANS OF STRUCTURED EXPERT JUDGMENT ELICITATION

Maria Nogal



TRINITY COLLEGE DUBLIN
COLÁISTE NA TRÍONÓIDE, BAILE ÁTHA CLIATH

THE
UNIVERSITY
OF DUBLIN



- Descriptor:
Intrinsic vulnerability, $V_{i,j}$: susceptibility to incidents characterised by their random occurrence in space and time that can result in considerable reduction or loss of the functionality.
- Indicators:
Reliability ($R_{i,j}$) & accessibility ($A_{i,j}$).

ELICITATION OF DEPENDENCE MODELLING

Calibration Variables		Variables of Interest (percentile 50)	
		ODs	$Prob(V_{i,j} A_{i,j})$ $Prob(V_{i,j} A_{i,j}, R_{i,j})$
$Prob(A_{25,69} A_{32,92})$	0.499	20-25	
$Prob(A_{32,92} A_{69,92})$	0.455	25-69	
$Prob(A_{25,69} A_{32,92}, A_{69,92})$	0.500	32-69	<i>Unknown values</i>
$Prob(R_{25,69} R_{32,92})$	0.575	32-92	
$Prob(R_{32,92} R_{69,92})$	0.871	69-92	
$Prob(R_{25,69} R_{32,92}, R_{69,92})$	0.563		

Introduction

Context

Resilience
assessment

Goal

How

Structured
expert judgment

What is it?

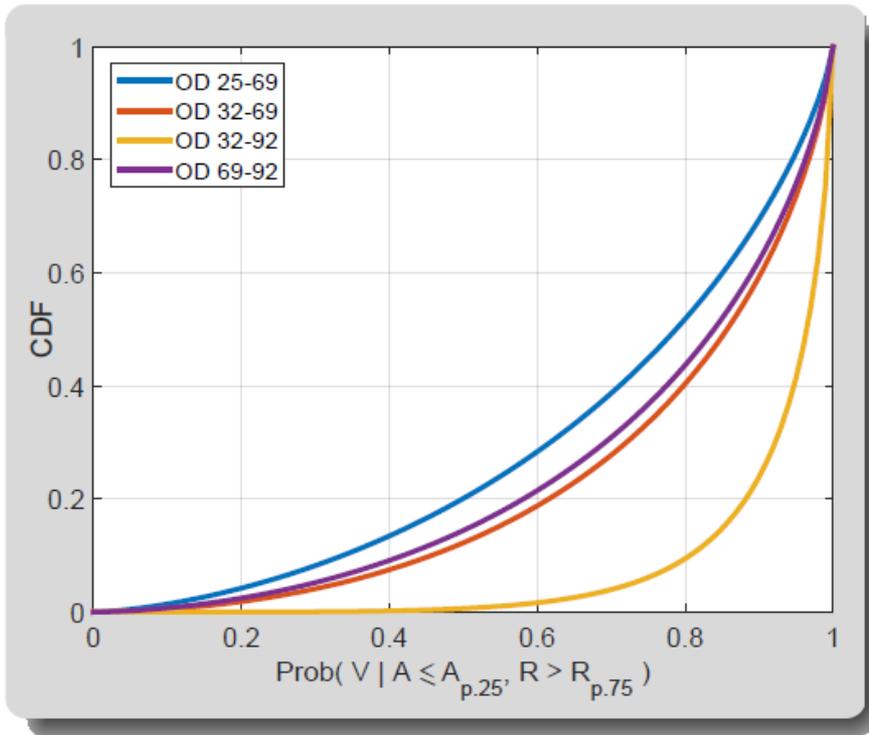
Mathematical
foundation

Proof of
Concept

Intrinsic
vulnerability

Results

Conclusions



OD	$r(R, A)$	$r(A, V)$	$r(V, R)$	$r(R, V A)$
20-25	0.97	-0.15	-	-
25-69	0.64	-0.12	0.17	0.32
32-69	0.68	-0.15	0.20	0.42
32-92	0.71	-0.21	0.35	0.74
69-92	0.72	-0.12	0.17	0.38

- Reliability and accessibility are both **valid indicators** to assess the intrinsic vulnerability of the network.
- **Other indicators are required** to explain a high percentage of the vulnerability.
- **The most vulnerable ODs** can be identified.

STRUCTURAL ELICITATION FOR BAYESIAN NETWORKS

- STSM of Sophia Wright (Warwick University), together with Tina Nane (TU Delft) and Anca Hanea (Cebra, Melbourne University), November 2016 and February 2017
- Learning the structure of a BN
 - Need for a performance-based elicitation protocol
 - How can we measure performance when eliciting the structure of a BN?
- Setting – citation analysis
 - Data – citation performance of Canadian researchers
 - Experts – 5 experts in citation analysis from CWTS, Leiden University

STRUCTURAL ELICITATION FOR BAYESIAN NETWORKS

- The approach

- Expert

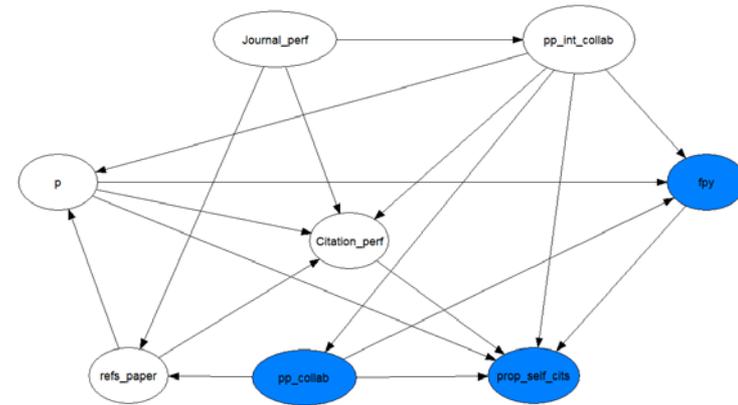
1. Ask experts about conditional distribution of the variables of interest (IDEA protocol implemented with two rounds of Classical Model)

- Data

2. Assign arcs in a particular order
3. Compute the conditional distribution of the variables of interest
4. Repeat 2&3

- Compare the conditional distributions in 1 and 3

- Choose the conditional distribution from the data closest to the conditional distribution from experts (with respect to a particular distance)



STRUCTURAL ELICITATION FOR BAYESIAN NETWORKS

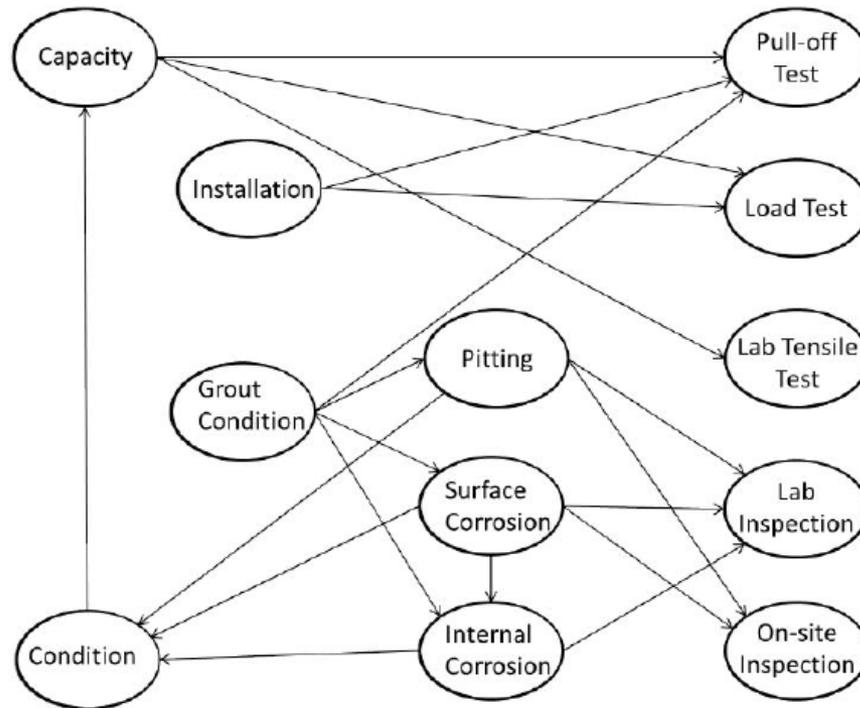
- Conclusions
 - Regardless the arcs assignment, the conditional distribution of the variables of interest might not change
 - Given a particular structure of the BN, the experts can assess conditional distributions of the variables of interest quite accurately
 - IDEA can help experts to become better calibrated
 - IDEA can increase the performance of the DM

The SHeffield ELicitation Framework and vine copulas in the specification of prior distributions for multinomial models

Kevin Wilson

School of Mathematics and Statistics, Newcastle University, UK
Thanks to Lesley Walls, John Quigley, University of Strathclyde

4th July 2017



- A group of engineers are responsible for a **large road bridge**.
- The bridge is coming to the end of its **useful life**.
- The engineers would like to assess the **condition** of the bridge.

- Typical approaches to eliciting priors for multinomial distributions **restrict** the possible dependence structures.
- Vines can give a more flexible dependence specification, with the **same number** of expert specifications.
- **D-vines** represent a suitable vine structure and **parametric copulas** contain the flexibility for the required dependency.
- The elicitation can be expressed in terms of quantities about which we could **ask** an expert.

REFLECTION

- › Good Progress
 - › As evidenced by previous slides
 - › In good measure thanks to the COST Action
- › Still much to do
 - › Process
 - › Theory
 - › Applications