Risk Management

Using Bayesian Networks and BayesiaLab
Introduction

Your Hosts Today

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Today’s Objectives

Methodological Objective

• Bayesian Networks for Managing Risk

Substantive Research Objective

• Quantifying and mitigating the risk of speeding violations in a transportation business context

“TOY PROBLEM”
Today’s Agenda

Motivation & Background
• Regulations & Risk
• Qualitative Risk Assessment
• Risk Mitigation Proposal

Methodologies
• Bayesian Networks for Reasoning Without Data
• The Delphi Method
• The Bayesia Expert Knowledge Elicitation Environment (BEKEE)

Software Demo
• Building the Qualitative Structure
• Eliciting Probabilities with BEKEE
• Finding the Optimal Policy
Webinar Slides & Recording Available

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Today’s Domain: Transport & Logistics
Law

- Regulation

- Speed Limit: 55

Business

- The Need for Speed

- Business Requirement

- FedEx: The World On Time

- Amazon Prime Now: Ultra-fast Delivery
3 vehicles in West Vancouver impounded in single night for excessive speeding

DC To Increases Speeding Fines By 233% With New 'Draconian' Regulations

You Can Now Get A $17,000 Speeding Ticket in Britain

Spain's drivers have a new speeding which means you are facing a £400 fine for going JUST 1 mph over speed limit

CT'S SPEEDING LAMBOGHINI DRIVER ARRESTED ON N1 FREEWAY

Speeding drivers face fines for going 1mph over limit: Police want zero tolerance

You're being warned that they could soon face fines for going just one mph over the limit in a proposal from police chiefs demanding motorists stop getting a 'soft ride'

Speeding Costs You

<table>
<thead>
<tr>
<th>Speed Fines</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>120 km/h</td>
<td>$100</td>
</tr>
<tr>
<td>130 km/h</td>
<td>$143</td>
</tr>
<tr>
<td>140 km/h</td>
<td>$295</td>
</tr>
</tbody>
</table>

Speeding Max $1000

Reckless Driving Max 8 Yrs
Qualitative Risk Assessment

Risk

Speed

SPEED LIMIT 55

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Risk Management

Premise

• Human drivers are always at a risk of violating traffic rules, including speed limits.

Proposal for Risk Mitigation

• Equip vehicle fleet with radar detectors to reduce the risk of speeding violations.

Note

• We are only considering the risks of violating the law and its consequences, such as penalties, suspension of privileges, arrests, or vehicle seizures.
• We are not looking at accident risks related to speeding, which of course exist.
• We assume that radar detectors are legal for the purpose of this study, which is not the case in many jurisdictions.
Note: We do not advocate speeding or the use of radar detectors. Always obey all applicable traffic laws in your jurisdiction.
Risk Management

Study Questions

• What is the base risk without radar detectors?
• By how much do radar detectors reduce the risk of speeding violations?
• What is their expected economical value to an organization?
• Do they potentially lead to unintended consequences?
But what if we don’t have any data...
No Data?

“Without data, you’re just another person with an opinion.”

W. Edwards Deming
Bayesian Networks to the Rescue!

Bayesian Networks

Model Purpose

Association/Correlation  Prediction  Explanation  Simulation  Attribution  Optimization

Data  Model Source  Theory

BayesiaLab.com
Bayesian Networks to the Rescue!

Even without data, humans do possess useful knowledge, qualitative or quantitative, tacit or explicit, about many aspects of the world.

Reasoning Without Data

Model Purpose

Association/Correlation

Description

Prediction

Explanation

Simulation

Attribution

Optimization

Causation
Bayesian Networks to the Rescue!

Webinar on March 2, 2018

Reasoning Without Data

BayesiaLab.com
Reasoning Without Data

One Expert

Last Week
Knowledge Elicitation — Individual Biases

Examples

• Overconfidence
• Confirmation bias
• Framing effect
• Escalation of commitment
• Availability bias
• Illusion of control
• Anchoring bias
Reasoning Without Data

One Expert

Last Week → Today

A Group of Experts

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Knowledge Elicitation — Group Biases

Examples

• Groupthink ("toeing the line")
• Social loafing ("hiding in the crowd")
• Group polarization ("taken to the extreme")
• Escalation of commitment ("throwing good money after bad", "sunken costs fallacy")
The Delphi Method

Origins

• The original Delphi method was developed in the 1940s and 50s by Norman Dalkey of the RAND Corporation.

• The Delphi method was devised in order to obtain the most reliable opinion consensus of a group of experts by subjecting them to a series of questionnaires in depth interspersed with controlled opinion feedback.
The Delphi Method

Elicit Knowledge from Interacting Groups

• Take the positive, e.g.
  • Knowledge from a variety of sources
  • Creative synthesis

• Prevent the negative, e.g.
  • Groupthink (“toeing the line”)
  • Social loafing (“hiding in the crowd”)
  • Group polarization (“taken to the extreme”)

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The Delphi Method

The Classical Delphi

- Interviews via questionnaires
- Anonymity of participants
- Iteration
- Controlled feedback
- Statistical aggregation
First Experimental Application

“to solicit expert opinion to the selection, from the point of view of a Soviet strategic planner, of an optimal U.S. industrial target system...”
The Delphi Method

“In view of the absence of a proper theoretical foundation and the consequent inevitability of having, to some extent, to rely on intuitive expertise—a situation which is still further compounded by its multidisciplinary characteristics—we are faced with two options: we can either throw up our hands in despair and wait until we have an adequate theory enabling us to deal with socioeconomic and political problems as confidently as we do with problems in physics and chemistry, or we can make the most of an admittedly unsatisfactory situation and try to obtain the relevant intuitive insights of experts and then use their judgments as systematically as possible.”

Olaf Helmer

March 1967
The Bayesia Expert Knowledge Elicitation Environment (BEKEE)

Utilizing Bayesian Networks with the Delphi Method
BEKEE Workflow

1. Brainstorming & Model Construction
   - Variables of interest
   - Causal relationships
   - Discretization levels

2. Knowledge Elicitation (interactive/offline)
   - Facilitator posts assessment tasks
   - Participants submit assessments

3. Inference & Optimization
1. Brainstorming & Model Construction

- Variables of interest
- Causal relationships

Facilitator

Experts

Qualitative Network

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2. Knowledge Elicitation

BAYESIALAB

BEKEE Server

Facilitator

Quantitative Elicitation

Experts

Web Client
Inference, Analysis, and Optimization
Building the Bayesian Network Model
Qualitative Bayesian Network Structure from Brainstorming
“Parameters” from BEKEE
In Conclusion...
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• March 16  Optimizing Health Policies with Bayesian Networks
• March 23  t.b.d.

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Thank You!

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