

Institution: University of East Anglia
Unit of Assessment: 11- Computing Science and Informatics
Title of case study: Improved Insurance Products for the Multinational Insurance Industry
<p>1. Summary of the impact</p> <p>Our research has been applied directly by <i>Aviva plc.</i> to develop improved products in the general insurance market (e.g. household and car) and in the more specialised area of enhanced pension annuities. As a result, <i>Aviva</i> has become more competitive in these markets and customers are enjoying better value for money. In the case of enhanced annuities, the benefits are in the form of higher pension income for those accurately identified as facing shortened life expectancies. <i>Aviva</i> is the largest insurance company in the UK and the sixth largest in the world.</p>
<p>2. Underpinning research</p> <p>This case study is based on a body of research undertaken within the School of Computing Sciences at UEA over a period of 20 years. Two different areas of research directly underpin the impact: research into data-mining, and statistical analysis.</p> <p>Beginning in the early 1990s, Rayward-Smith led a research group that developed optimisation algorithms. As one of the pioneers of emergent computation, he first demonstrated its effectiveness in solving the graphical Steiner tree problem in 1993. Building on this work, Rayward-Smith and de la Iglesia developed new approaches to solving optimisation problems by developing metaheuristics and, by the mid-to-late 1990s, the expertise was being applied within the newly emerging discipline of data mining. This led to one of the first descriptions of how data mining can be used in industrial applications (which appeared in the collection "<i>Industrial Knowledge Management</i>", Dr. Rajkumar Roy (Ed), Springer-Verlag, London, 2001). Applications included new methods for companies to develop and maintain complex software systems [1] and the use of metaheuristics to mine insurance data [2]. More recent contributions on the use of metaheuristics in data mining include work on multi-criteria optimisation [3].</p> <p>In March 2010, Kulinskaya joined the School as the <i>Aviva</i> Chair in Insurance Statistics, which was established to develop new research in insurance statistics. Kulinskaya brought her expertise in meta-analysis and evidence synthesis. These are statistical techniques that amalgamate information from disparate sources so as to obtain more reliable evidence. They had been used widely in medicine and social sciences, but not in insurance.</p> <p>Since arriving at UEA, Kulinskaya and colleagues have developed a novel approach to combine statistical evidence based on variance stabilising transformations [4], for application to evidence synthesis in insurance. When several studies on the same topic are available, a combined meta-analytic estimate of a parameter of interest is a weighted mean of estimates obtained in individual studies. The weights are inversely proportional to the variances, so that the most precise studies have the largest weights. Most of the meta-analysis literature assumes known weights, which can lead to misleading conclusions when combining the evidence. In fact, the variances are themselves estimates and therefore subject to uncertainty. The cases when the weights depend on the unknown parameters are the most problematic. Variance stabilisation methods transform the data so that the variances become constant, thus eliminating this problem and resulting in more precise decisions. Additionally, Kulinskaya developed an improved methodology for testing homogeneity in meta-analysis [5]. In parallel, cardio-vascular risk and life expectancy models have been developed by de la Iglesia [6]. These two areas of research are now being applied to the development of a methodology for actuarial meta-analysis to investigate mortality in a variety of chronic medical conditions.</p> <p>Key Research Personnel Professor Vic Rayward-Smith (1993 to 2012, now Professor Emeritus) Professor Elena Kulinskaya (2010 to date)</p>

Impact case study (REF3b)

Dr Beatriz de la Iglesia (1994 to date)

In addition, 12 past and current PhD students have contributed to research in these areas.

3. References to the research

(UEA authors in bold; citations taken from Google Scholar on 14/11/13)

- [1] **Bagnall, A.J., Rayward-Smith, V.J.**, Whittlely, I.M.
The next release problem.
Information and Software Technology **43** 883–890 (2001) (161 citations)
doi: 10.1016/S0950-5849(01)00194-X
- [2] **Rayward-Smith, V.J., Debuse, J.C.W., de la Iglesia, B.**
The use of modern heuristic algorithms for mining insurance data.
in Handbook of Data Mining and Knowledge Discovery ed. W. Klogsen and J. Zytkow, (2002)
pp.849-856, Oxford University Press
ISBN: 0195118316
- [3] **de la Iglesia, B., Richards, G., Philpott, M.S., Rayward-Smith, V.J.**
The application and effectiveness of a multi-objective metaheuristic algorithm for partial classification.
European Journal of Operational Research **169** 898-917 (2006) (31 citations)
doi: 10.1016/j.ejor.2004.08.025
- [4] **Kulinskaya, E.**, Morgenthaler, S., Staudte, R.
Variance stabilizing the difference of two binomial proportions.
The American Statistician **64** 350-356 (2010) (5 citations)
doi: 10.1198/tast.2010.09080
- [5] **Kulinskaya, E.**, Dollinger, M.B., Bjørkestøl, K.
Testing for homogeneity in meta-analysis I. The one parameter case: Standardized Mean Difference.
Biometrics **67** 203–212 (2011) (5 citations)
doi: 10.1111/j.1541-0420.2010.01442.x
- [6] **de la Iglesia, B., Potter, J. F.**, Poulter, N.R., Robins, M.M., **Skinner, J.**
Performance of the ASSIGN cardiovascular disease risk score on a UK cohort of patients from general practice.
Heart, **97** 491-499 (2011) (21 citations)
doi: 10.1136/hrt.2010.203364

External Research Funding

1. Modern Heuristic Techniques in the Insurance Industry
EPSRC / Norwich Union (1994 -1997) £155,000
G. D. Smith, V. J. Rayward-Smith and G. P. McKeown
This Programme was given an Alpha 5 (top) rating by EPSRC. De la Iglesia was one of the two associates.
2. Optimisation in Simulation Models
Lanner Group (1997-1998) £34,525
G. D. Smith, G. P. McKeown and V. J. Rayward-Smith
3. Multi-objective meta-heuristic algorithms for finding interesting rules in large complex databases
EPSRC (2004-2007) £126,751
B. de la Iglesia
4. Funding to support Aviva chair
Aviva (2009 - to date) in excess of [REDACTED]

4. Details of the impact

Aviva is a British multinational insurance company, the largest in the UK and the sixth largest in the world, as measured by net premium income, and has around 43 million customers in 21 countries. It is the market leader in both general and life insurance in the UK, and in 2012, had around 15% market share in general insurance, 25% market share in individual pension annuities, and 15% market share in life/critical illness term assurance. Our work on data mining and statistical analysis has been applied to two specific areas of *Aviva* business, the general insurance market and the pensions annuity market, to provide considerably better products for *Aviva* customers.

General Insurance

Aviva uses our research into meta-heuristic techniques and data mining for both pricing and marketing in general insurance (e.g. car and household). This is of direct benefit to general insurance customers, because adoption of these techniques allows a more competitively priced product to be offered to customers, whilst still maintaining *Aviva*'s profitability. In particular, data mining techniques have been applied to *Aviva*'s Personal Lines Pricing. Insurance premiums are calculated using scoring derived from the applicant's attributes and history: for instance, for car-insurance, these might be gender, age, car-model, accident history etc. We developed methods of scoring these factors that enabled *Aviva* to refine their risk cost and behavioural modelling and hence to increase the competitiveness of their quotations. Data mining techniques are also used in the development and implementation of predictive models for targeted marketing campaigns. This has materially improved *Aviva*'s marketing and pricing capability, as indicated below in a statement by the **Managing Director, At Retirement, Aviva UK Life Ltd.:**

'UEA's research in data-mining has been integral in changing the way in which Aviva prices general insurance products. It is also used in our predictive models for targeted marketing campaigns. Insurance is a very competitive industry and correct pricing and marketing are core to our survival. It's difficult to quantify the exact savings that UEA's input has made to Aviva, but it would certainly run into many millions.'

(taken from corroborating source A)

The use of these techniques within the company is greatly enhanced by our training of *Aviva* data-analysts via an in-house MSc developed by the School specifically for *Aviva* and which has already been attended by over 100 *Aviva* staff.

Annuities

An annuity provides an individual with a regular income for remaining life in exchange for a lump sum, typically accumulated through a personal pension. Life expectancy is a key determinant of the regular income that can be purchased with a given lump sum. "Enhanced (impaired lives) annuities" provide more income for a given lump sum for individuals known to have conditions that shorten their life expectancy and are a growing area of business for *Aviva*. Until recently, all the risk analysis and hence pricing of enhanced annuities were out-sourced to secondary re-insurance companies, resulting in a 'black box' approach to the products on offer, so that a quote for an annuitant was offered without *Aviva* control or contribution. Based on the UEA research in meta-analysis, a joint UEA and *Aviva* team under the leadership of Kulinskaya has produced three confidential technical reports that assess the main insurance risks in the three most prevalent chronic medical conditions within the annuities market

enabling it to be more competitive in this market and to generate a significant increase in its share of the profit from enhanced annuities.

Underlying this important business development is a new two-pronged approach to the evidence-based pricing of enhanced annuities, developed by the UEA/*Aviva* team:

- the use of meta-analysis and evidence-synthesis of the published studies to assess the effects on longevity of a number of chronic medical conditions,
- a state-of-the-art large-scale longitudinal analysis of primary care data informed by the obtained evidence-base.

Both steps are being implemented by the joint UEA/*Aviva* team. To date, this has been completed

Impact case study (REF3b)

for myocardial infarction and diabetes. The UEA contribution is evidenced by the following statement by the **Head of Underwriting, At Retirement, Aviva UK Life Ltd.:**

'She [Professor Kulinskaya] has made a significant contribution to our development and understanding of longevity. [...] Professor Kulinskaya's pioneering work on survival models has provided Aviva with confidence that these models underpinning our guarantees to customers are sound and robust'

'The relationship with UEA and Professor Kulinskaya in particular has helped Aviva avoid consultancy costs that would have amounted to an estimated £150 000 over the project life.'

'In studying specific conditions affecting longevity we have found the research input from Professor Kulinskaya to be of a greater quality than many other agencies offering professional services in this arena. ...'

'It is difficult to quantify what this will be worth but the market size for medically enhanced annuities is estimated at £4bn annually with Aviva looking to take at least a 25% share....'

'The potential benefit could run into several million pounds.'

(taken from corroborating source E)

5. Sources to corroborate the impact

- A. Letter from the Managing Director, *At Retirement, Aviva UK Life Ltd.* and held on file at UEA
- B. Wright, N., Kulinskaya, E., Richards, G., De La Iglesia, B.
[REDACTED]
Confidential technical report, June 2011, 42 pages.
(held on file at UEA)
- C. Kulinskaya, E. and Wright N.
[REDACTED]
Confidential technical report, November 2012, 50 pages
(held on file at UEA)
- D. Kulinskaya, E., Gitsels, L. and Wright N.
[REDACTED]
Confidential technical report, June 2013, 66 pages
(held on file at UEA)
- E. Letter from the Head of Underwriting, *At Retirement, Aviva UK Life Ltd.* and held on file at UEA