Society of Actuaries in Ireland

Life Reinsurance Forum 2019

16th April 2019

Disclaimer

The views expressed in this presentation are those of the presenter(s) and not necessarily those of the Society of Actuaries in Ireland or their employers.

Society of Actuaries in Ireland

Introduction

Gavin Maguire

Life Reinsurance Committee

- Gavin Maguire (Chair)
- Sarah Lynch (Secretary)
- Aisling Bradfield
- Michael Culligan
- Ciara Fitzpatrick
- Thomas Moran
- Brian Morrissey
- Niall Mulvey
- Michelle Neary
- Viviana Pascoletti
- Cillian Ryan
- Philip Shier

Life Re Committee

- Input into consultation responses issued to external parties (e.g. regulators, policymakers, Actuarial Association of Europe, AAE)
- Work with other committees of the Society so as to ensure consistency of views and a coherent approach
- To provide CPD and training opportunities for Members of the Society

Life Re Committee

- How do we better serve the wider membership?
- Particularly those in Non-Reserving or Non-HoAF roles?
- Working through a review of ToR and Modus Operandi
- Call for membership

Agenda

The Theme for today is Data Analytics

Speaker(s)
Professor John Kelleher ADAPT Centre
Karl Murray & Eamon Comerford Milliman
John Nolan Hannover Re Aisling Bradfield SCOR

Society of Actuaries in Ireland

Life Reinsurance Forum 2019

Prof. John Kellegher

Society of Actuaries in Ireland

Data science usage and applications in life (re)insurance

Karl Murray & Eamon Comerford

Data science usage and applications in life (re)insurance

Eamon Comerford
Karl Murray

16 APRIL 2019

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Introduction

- Brief introduction to data science
- Results of recent [Milliman survey]
- Applications in life (re)insurance
- Other thoughts

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What is Data Science?

Artificial Intelligence

Data Mining

Machine Learning

Data Analytics

Data Cleaning

Business Intelligence

Data Engineering

Predictive Analytics

Data Strategy

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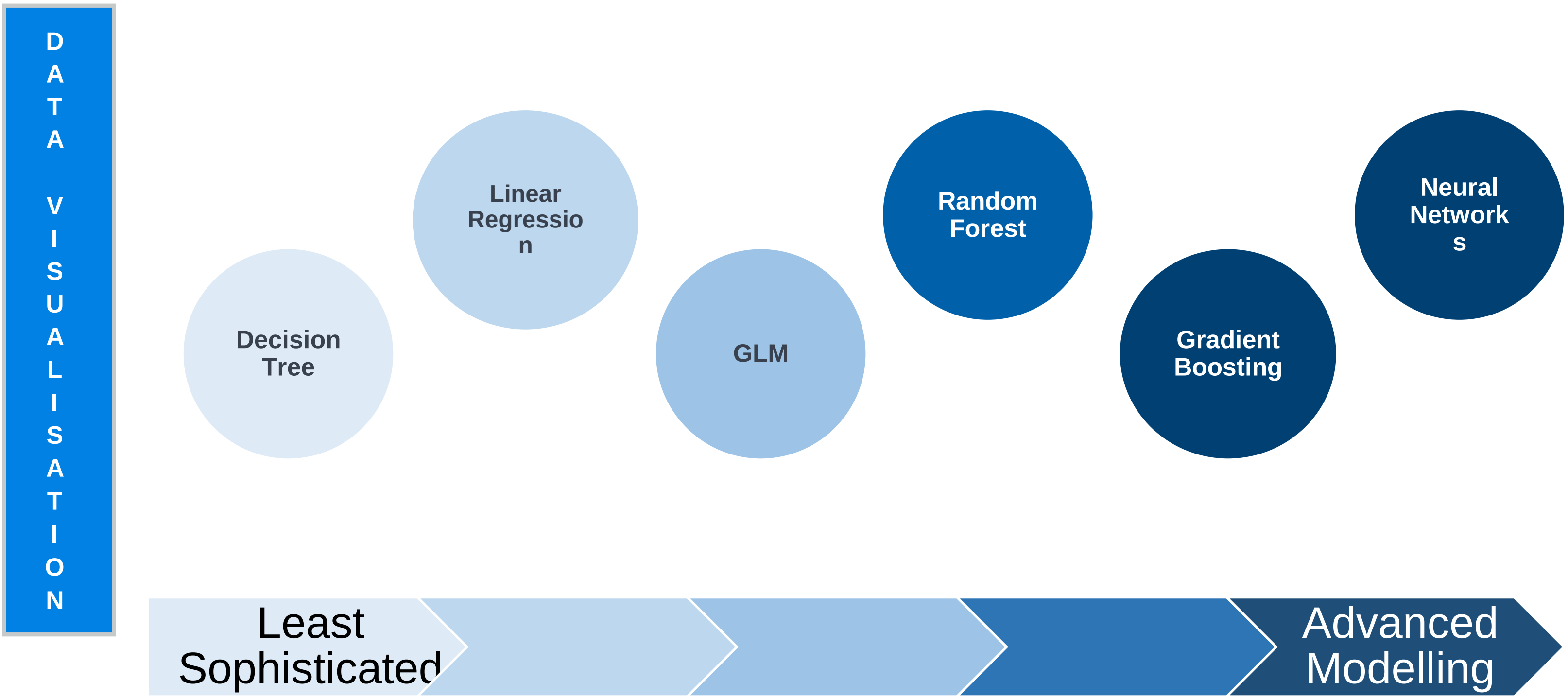
Data Science Methods

Tools and Techniques used in the application of Data Science

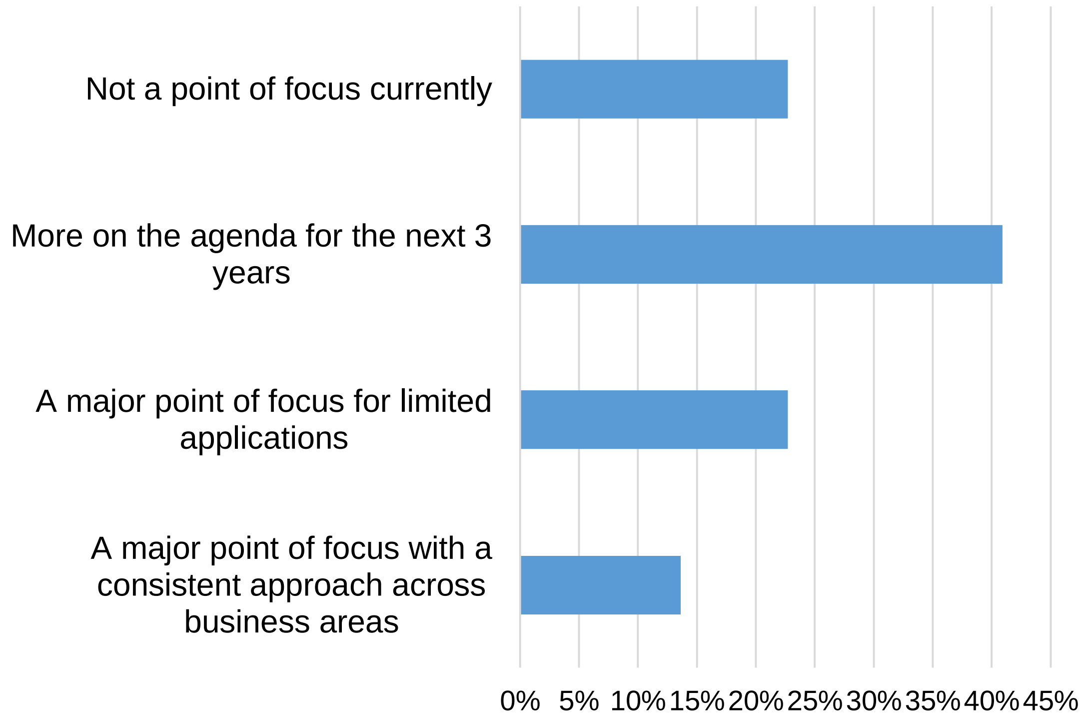


Milliman survey on the use of data science

- Scope & Strategy
- Data Usage
- Data Science Architecture and Tools
- Resourcing and Governance
- Benefits & Challenges

Results from our Client Survey

How does data science fit in to your organisation's overall strategy?



- ✓ Over 75% expect to be using data science within the next 3 years, with over 35% already making it a point of focus.

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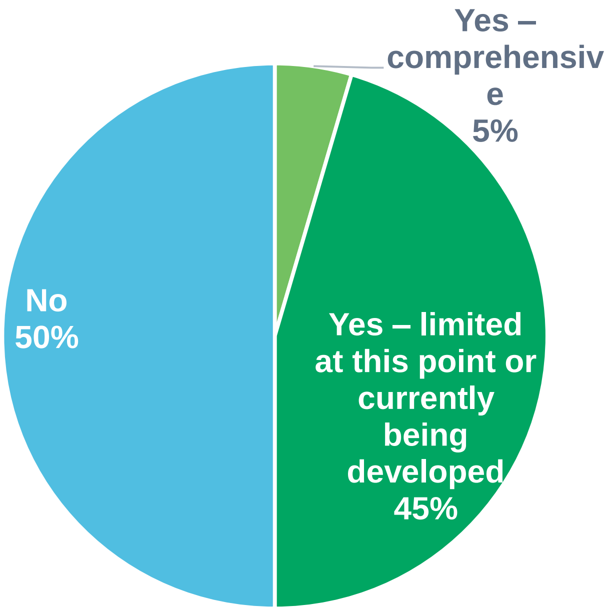
Results from our Client Survey

Does your organisation have a dedicated data architecture/infrastru



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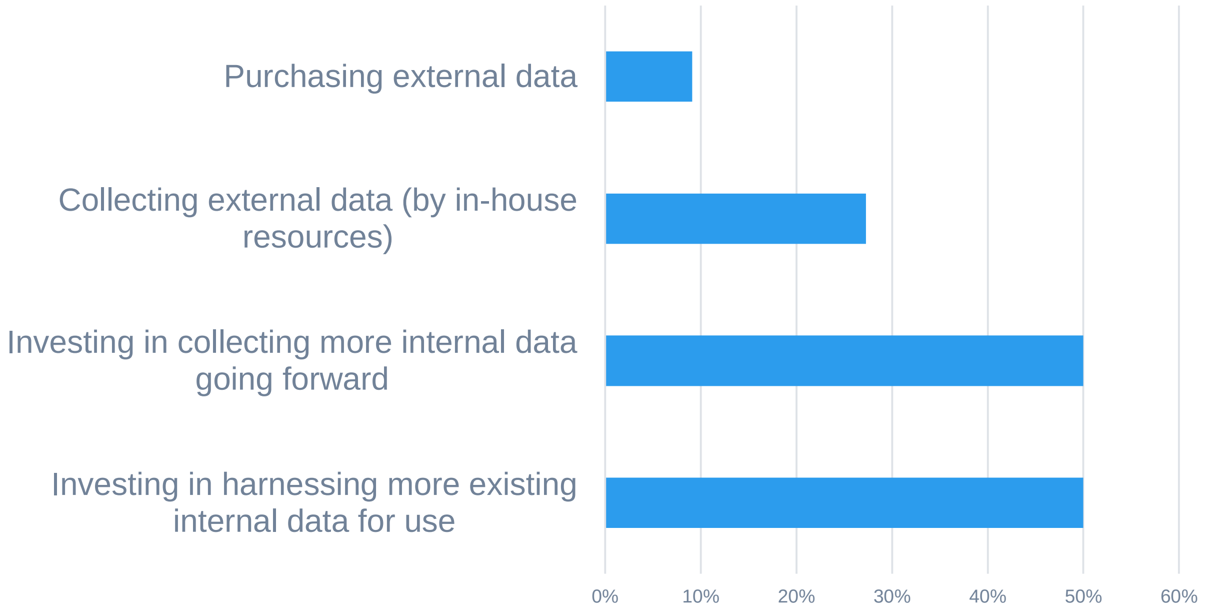
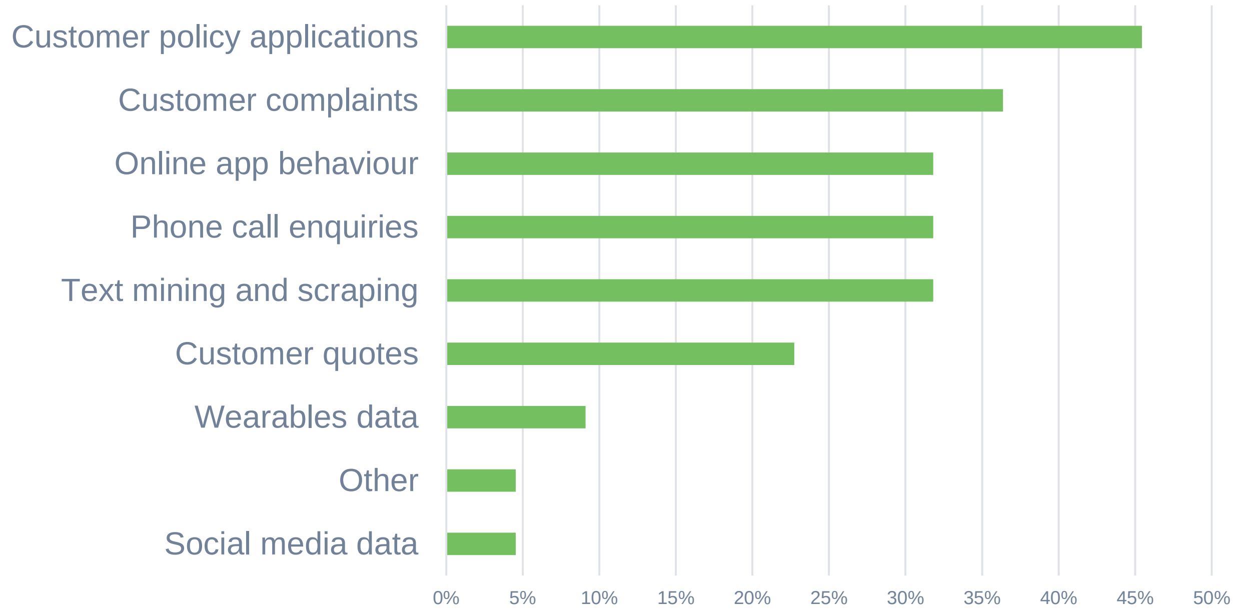
Results from our Client Survey

How would you describe your current activities relating to sourcing
Data Science applications?



Results from our Client Survey

Which of the following sources or methods have you used to captur
Science processing (or plan to use in the next 3 years)?



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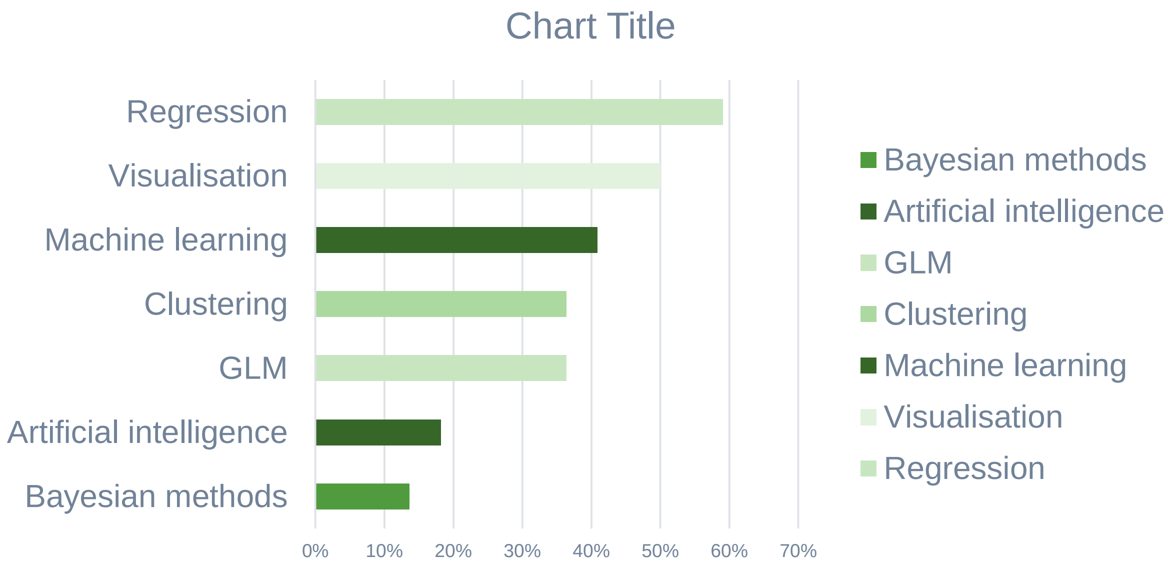
Results from our Client Survey

Which of the following types of tools or techniques have you used ir
Science (or plan to use in the next 3 years)?



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Milliman

Common tools

Programming language

R
python
julia
sas®
MATLAB

Visualisation

tableau
Power BI
Qlik

“Big data” sets

APACHE hadoop
APACHE Spark™

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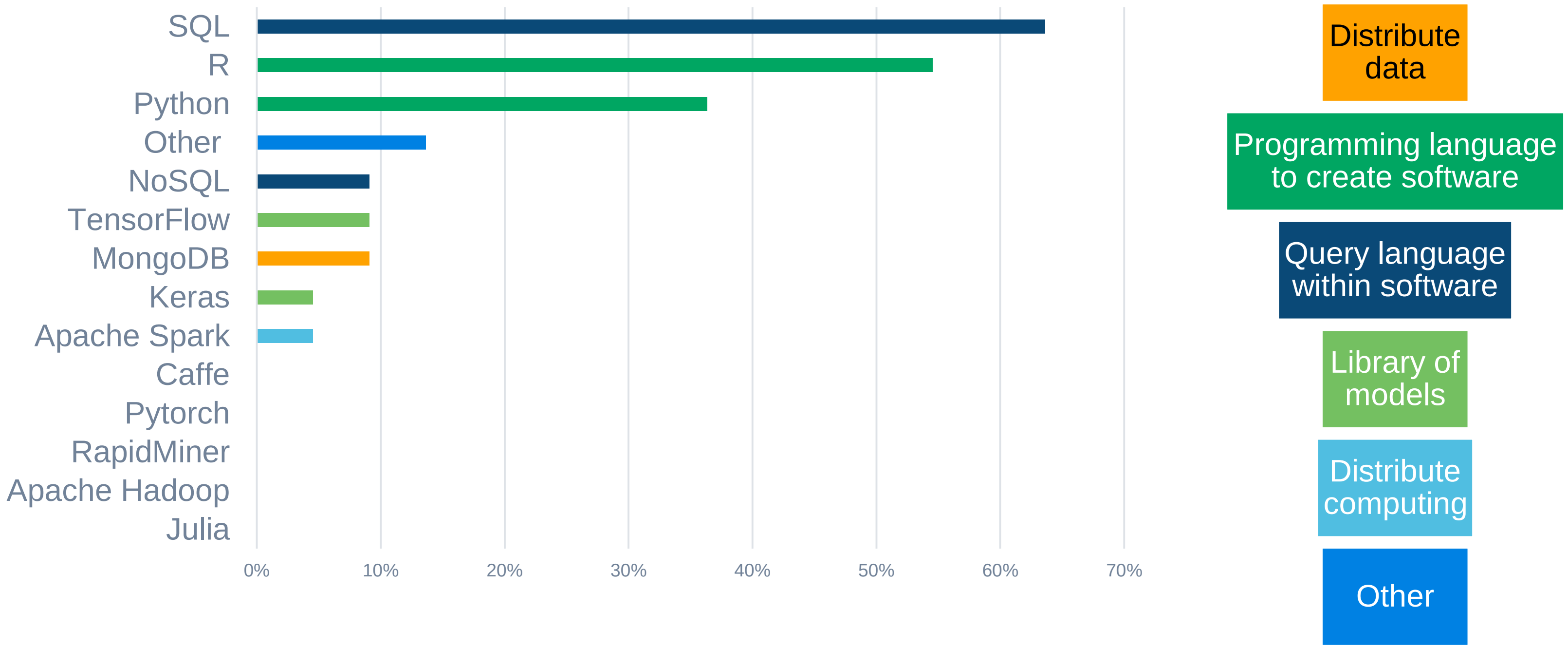
Results from our Client Survey

Software used



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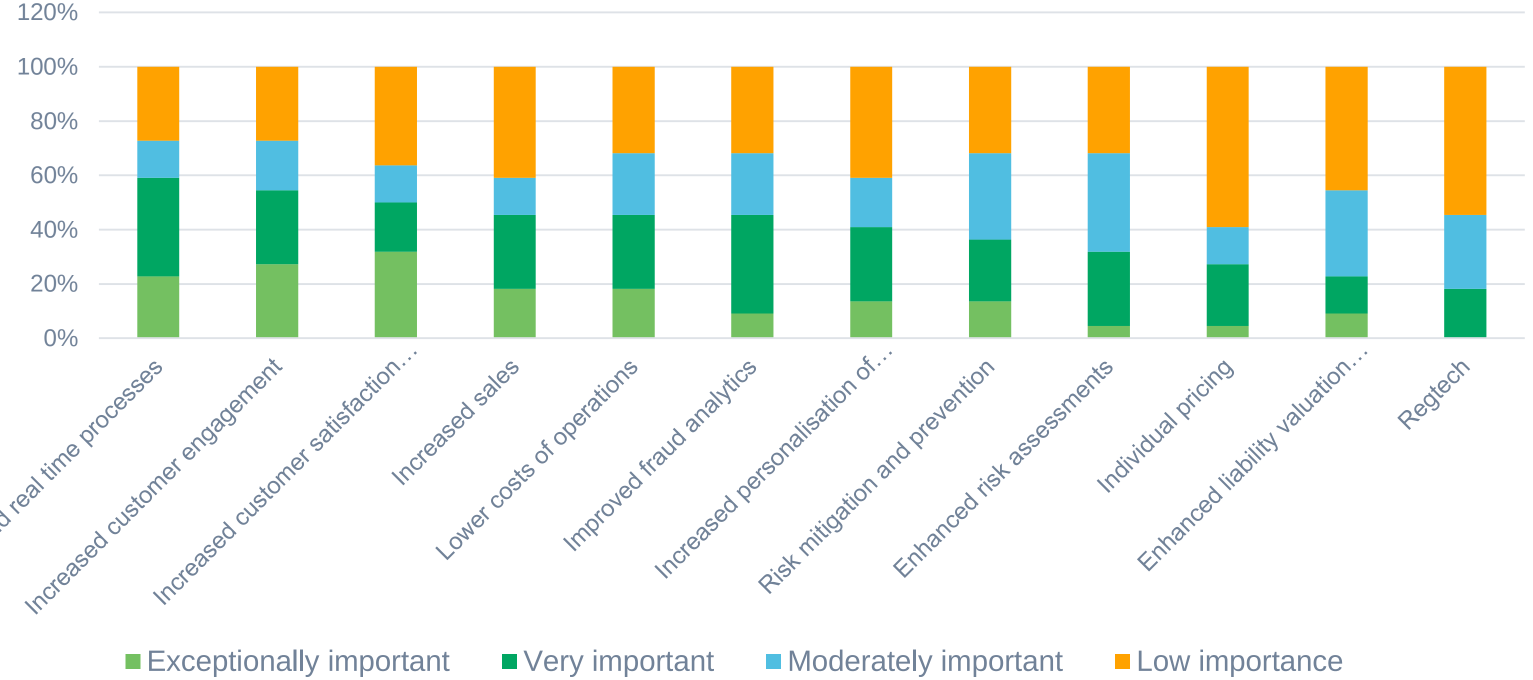
Results from our Client Survey

Main potential benefits?



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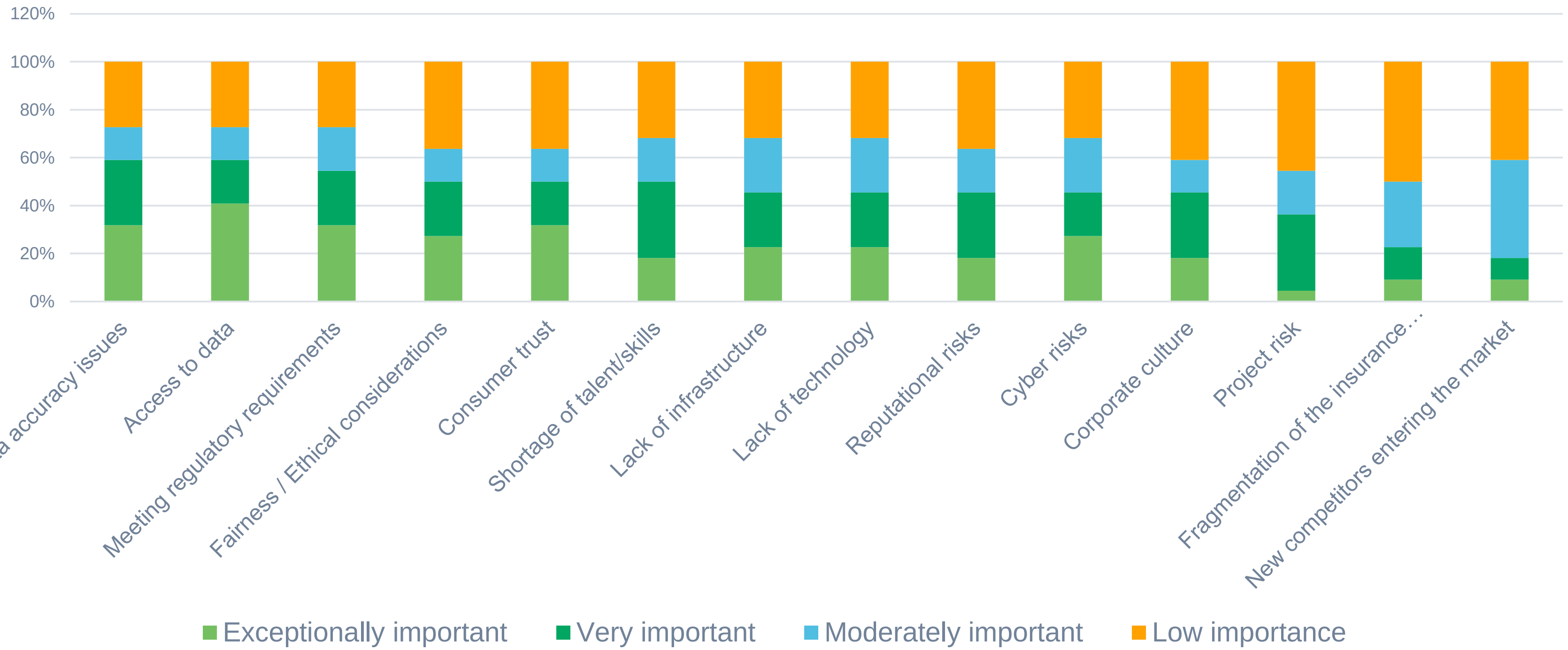
Milliman

Results from our Client Survey

How relevant are the following challenges for your organisation?



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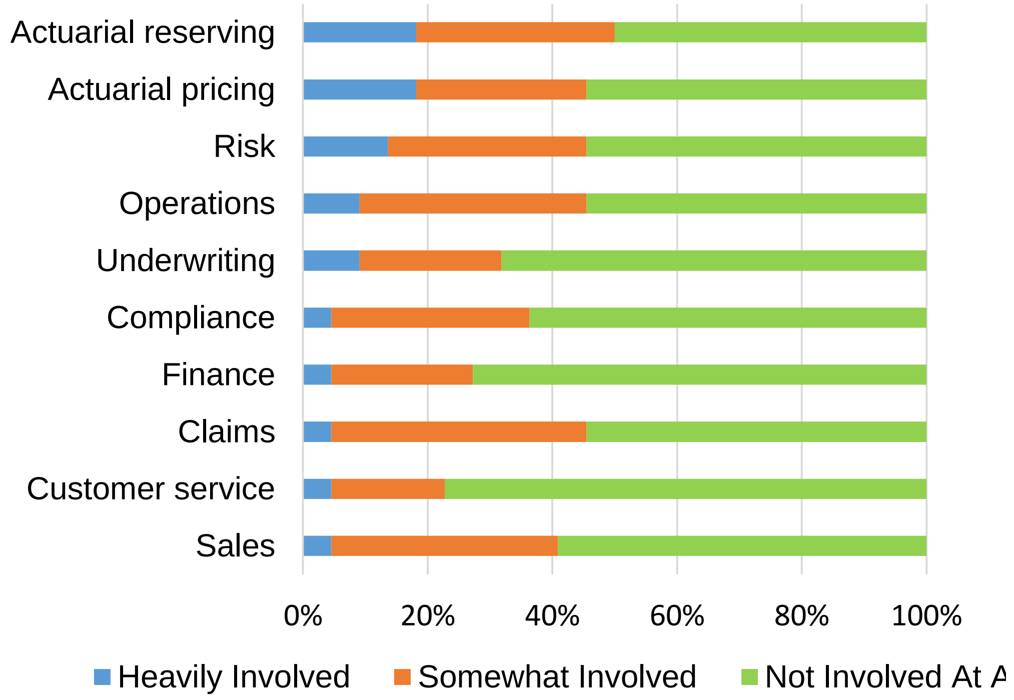
Results from our Client Survey

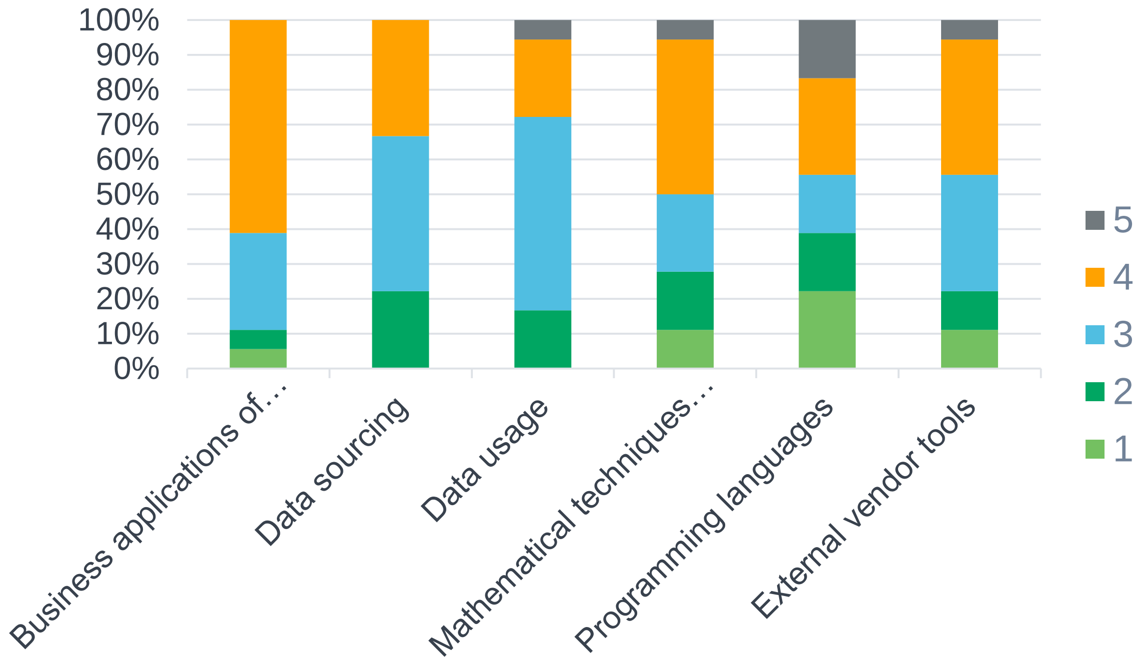
How involved are the business areas with data science applications?



- ✓ Actuarial and risk roles are the most heavily involved in data science applications.
- ✓ We would also expect an increased involvement over time from customer service, underwriting and sales functions.

Results from our Client Survey

What is the level of upskilling required by individuals in your organisation for the following areas?



- ✓ Significant skills gap in business applications of Data Science.
- ✓ All areas would benefit from an increase in the levels of training available to individual

- Range of 1-5
  - 1 = No upskilling
  - 5 = Significant upskilling

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Data Science Applications for Life (Re)insurance

Milliman Case Studies

Data validation and imputation

Dealing with incomplete and dirty data as well as a large number of diverse legacy portfolios

✓ Use of advanced techniques to identify missing data patterns to develop more credible experience analysis

Distributor Oversight

Improving distributor retention and performance

✓ Pinpoint underperforming distributors and improve allocation of company's resources

Model Validation

Validating an internal model that forecasts future risk exposure

✓ Develop a transparent and robust validation process

Customer Behaviour

Identifying the key drivers leading to transfers between unit-linked funds and guaranteed funds

✓ Understand policyholder behaviour and develop marketing actions to encourage/discourage the propensity to switch

Data Science Applications for Life (Re)insurance

Milliman Case Studies

Cross selling and discounts

Offering customers a discount for purchasing multiple product types

- ✓ Identify best targets, offers and delivery channels for different customer segments

Customer Engagement

Reducing high rates of policy lapsation

- ✓ Analytics on customer behaviour (e.g. premium payments, queries, complaints) to produce early warning indicators & trigger communications

Quotations and pricing

Asking fewer questions when offering an online quotation

- ✓ Improve customer experience and overall efficiency

Targeted Products

Understanding a complex target market with varied customer needs

- ✓ Improved product design and reduced conduct risk

Data Science Applications for Life (Re)insurance

Milliman Case Studies

Data Analysis Architecture

Developing a cohesive data strategy

- ✓ Development of a standardised data science framework across the organisation

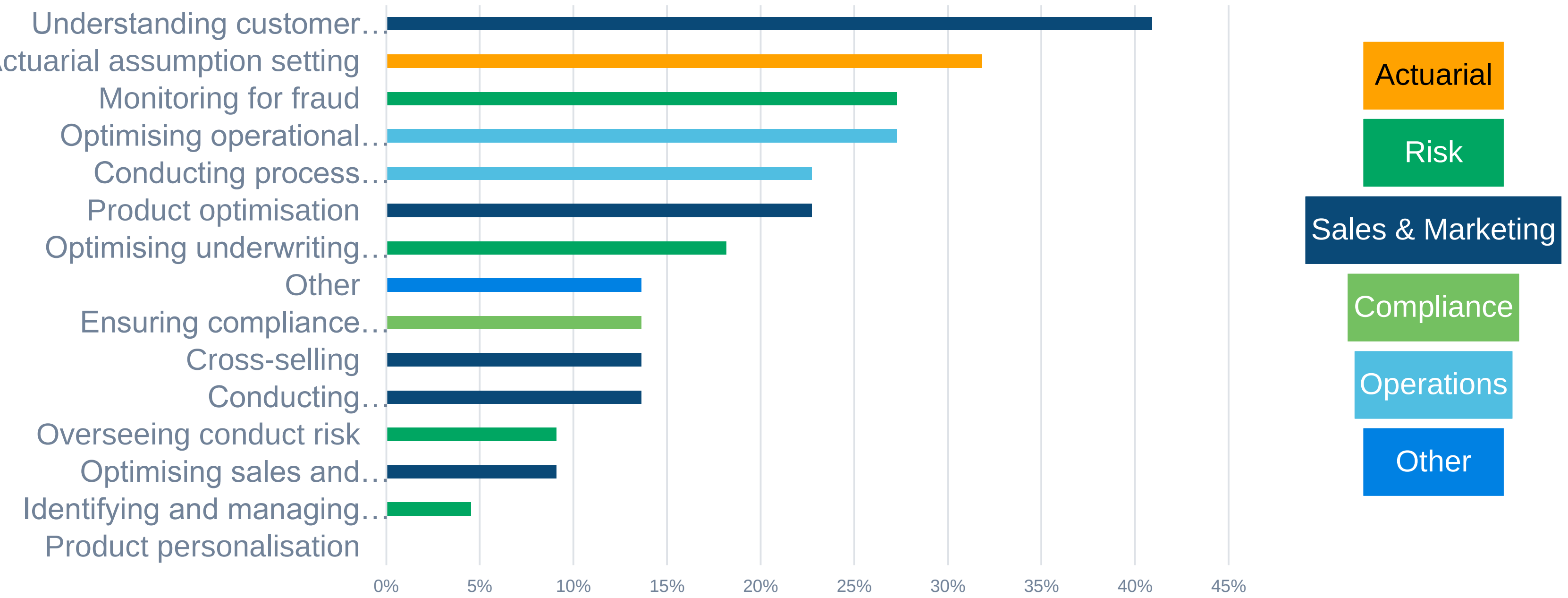
Inforce Management

Understanding customers' use of policy options

- ✓ Identify distinct customer segments and apply predictive modelling to create behavioural profiles for each segment
- ✓ Use insights from behavioural finance, consumer behaviour, family, health, and other facets of the lives of customers

Results from our Client Survey

For what business decisions or applications is Data Science used at your company?



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Starting a Data Science Initiative

Choosing the right project

Start with a narrowly scope and build on it

Align data science activities with the organisation's overall goals

Ensure adequate funding and access to data

Hiring the right people

Identify tradeoffs between budget and salaries, specialisation and generalisation etc.

Domain knowledge

Start small and grow over time

Key to Success

Creating the team

Encourage cross-functional knowledge sharing

Ensure that project managers have a strong technical understanding in order to have right expectations of their team

Data Governance

Develop an enterprise-wide set of principles around governance of data

Take advantage of emerging data sources such as sales and marketing data, lifestyle data captured by wearable devices, electronic medical records, etc.

The Data Question

- ✓ Data is everywhere
- ✓ First define the problem to be solved
- ✓ Importance of domain expertise
- ✓ Develop a framework for collecting data that is needed for this purpose
- ✓ Pay attention to GDPR and other legislative requirements
- ✓ Put a good data management structure in place

Key takeaways from survey

- Over 75% expect to be using data science within the next 3 years, with over 35% already making it a point of focus
- Most common uses of data science right now involve either assessment of customer behaviour or assumption setting
- Limited use of external datasets so far
- Actuaries and risk roles currently most heavily involved in applications
- Limited standardisation thus far around collection and use of data
- Data science is seen as a way to deliver major benefits in increasing customer engagement, increasing customer satisfaction and retention, increasing sales, improving fraud detection and achieving process efficiency
- Biggest challenges facing companies involve a lack of infrastructure and technology, cyber risks, regulatory expectations, a shortage of talent, data quality, and access to data

Thank you

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Society of Actuaries in Ireland

Data Analytics: Views from a Lapse and Mortality Perspective

John Nolan & Aisling Bradfield

Society of Actuaries in Ireland

Linking Traditional Valuation Models to Analytics
Platforms & Applications

John Nolan, FSAI

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Agenda

- One Model Concept:
  - Valuation & Financial Reporting Model
  - Economic Capital Model
  - Experience Analysis
- Analytics ready
- Applications

One Model Concept - Overview

- **Background:** 3 separate models existed
  - Valuation & Financial Reporting
  - Economic Capital Model (ECM)
  - Experience Analysis (EA)

- **Rationalising Models:**
  - Removed redundant assumptions and tables.
  - Removed over 50 tabs from our assumption file
  - Coding changes
  - One model: enhanced reporting model code for ECM and EA
  - Improved model governance:
    a) Model change policy
    b) Model change log
    c) Model run log

One Model Concept - Benefits

- One version of truth: Best Estimate
- No separate silos
- Efficiencies and Controls:
  - Efficiency of having a single set of controls applied to valuation and experience studies, rather than multiple independent controls
- A/E in same clean format
- Transparent

Analytics Ready

- **Common Questions:**
  - What do we need and how can we get there?
  - How can a Valuation Tool like Risk Agility give sufficiently granular detail?
- **Needs:**
  - Granular, segmented data
  - Leverage the "**group**" field in RAFM

"Group" String Structure			
description	**position**	**length**	**Example**
Treaty Code	1	2	TR
Single or Joint	3	1	S
Age Band 1	4	2	35
Sex 1	6	1	M
Smoker 1	7	1	S
Age Band 2	8	2	45
Sex 2	10	1	F
Smoker 2	11	1	N
Level / Decreasing	12	1	L
Sales Channel	13	1	I
Benefit Term	14	3	120
.....			
.....			
.....			
.....			
Final String:	**TRS35MS45FNLI120**		

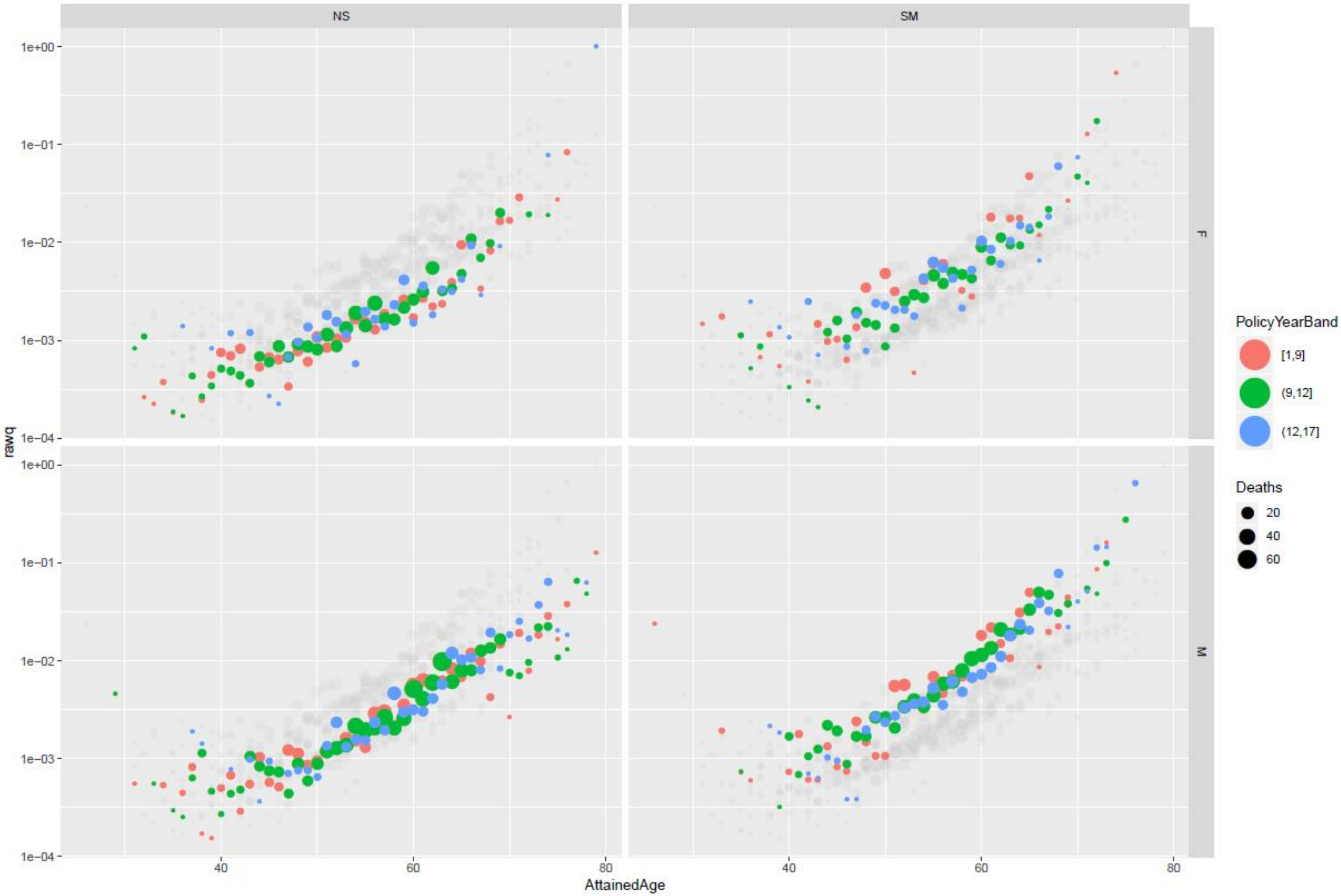
Analytics Ready

- Model Output:

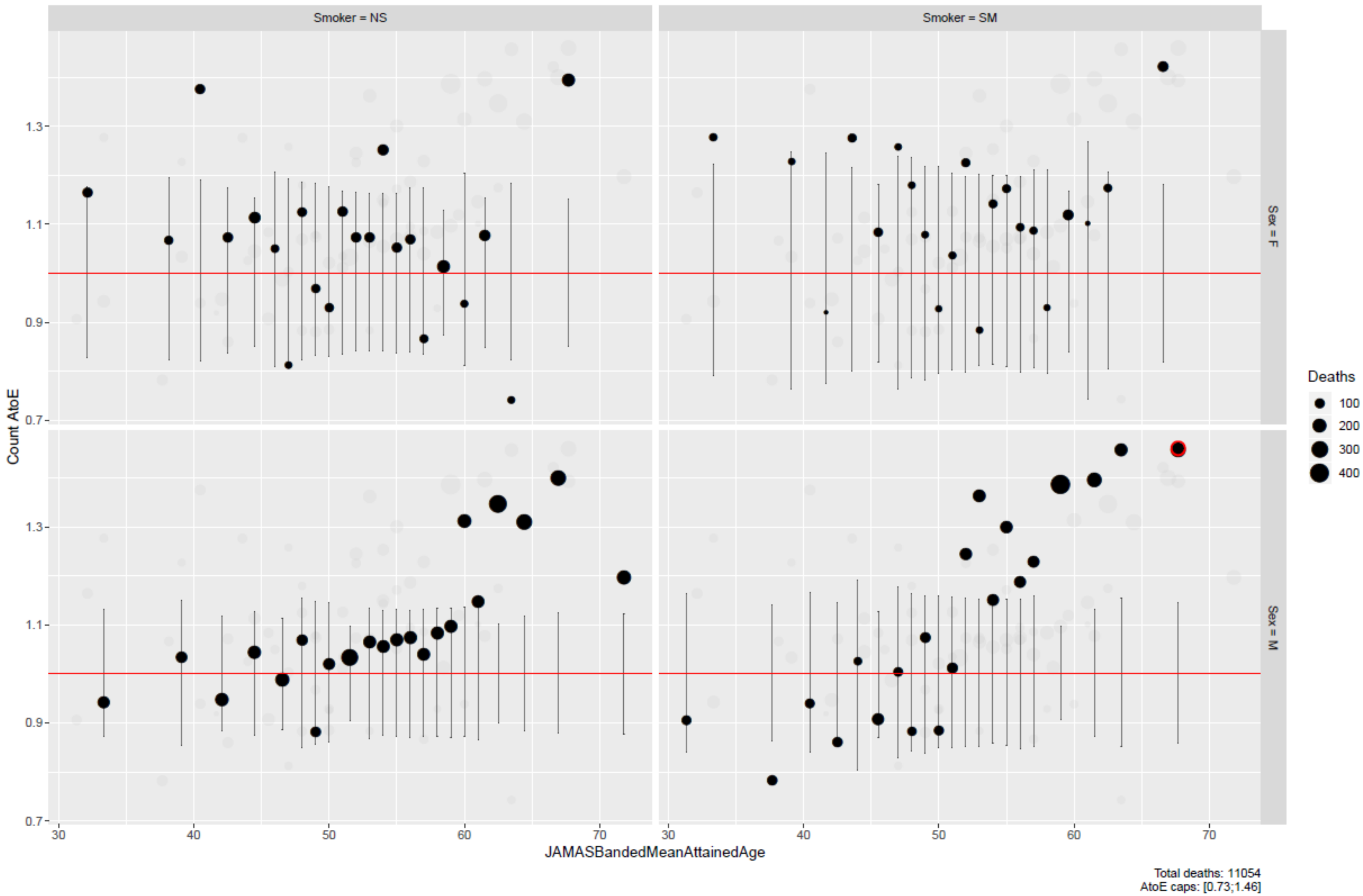
group	time	cal_year	pol_year	death_rate1_E	sum_insured1_E
TRS35MS45FNLI120	-150	2005	1	0.0010	1,000
TRS35MS45FNLI120	-149	2005	1	0.0011	1,100
TRS35MS45FNLI120	-148	2005	1	0.0012	1,210
TRS35MS45FNLI120	-147	2005	1	0.0013	1,331
TRS35MS45FNLI120	-146	2006	1	0.0015	1,464
TRS35MS45FNLI120	-145	2006	1	0.0016	1,611
TRS35MS45FNLI120	-144	2006	1	0.0018	1,772
TRS35MS45FNLI120	-143	2006	1	0.0019	1,949
TRS35MS45FNLI120	-142	2006	1	0.0021	2,144
TRS35MS45FNLI120	-141	2006	1	0.0024	2,358
TRS35MS45FNLI120	-140	2006	1	0.0026	2,594
TRS35MS45FNLI120	-139	2006	1	0.0029	2,853
TRS35MS45FNLI120	-138	2006	2	0.0031	3,138

Treaty	PolYear	CalYear	SexSmoker	AttainedAge	SalesChannel	......	Lives_E	Amounts_E
TR	1	2004	MS	25	I	......	0.005	12,000
TR	2	2005	MS	26	I	......	0.055	13,000
TR	3	2006	MS	27	I	......	0.105	14,000
TR	4	2007	MS	28	I	......	0.155	15,000
TR	5	2008	MS	29	I	......	0.205	16,000
TR	6	2009	MS	30	I	......	0.255	17,000
TR	7	2010	MS	31	I	......	0.305	18,000
TR	8	2011	MS	32	I	......	0.355	19,000

Developing Applications – Raw Mortality Plot



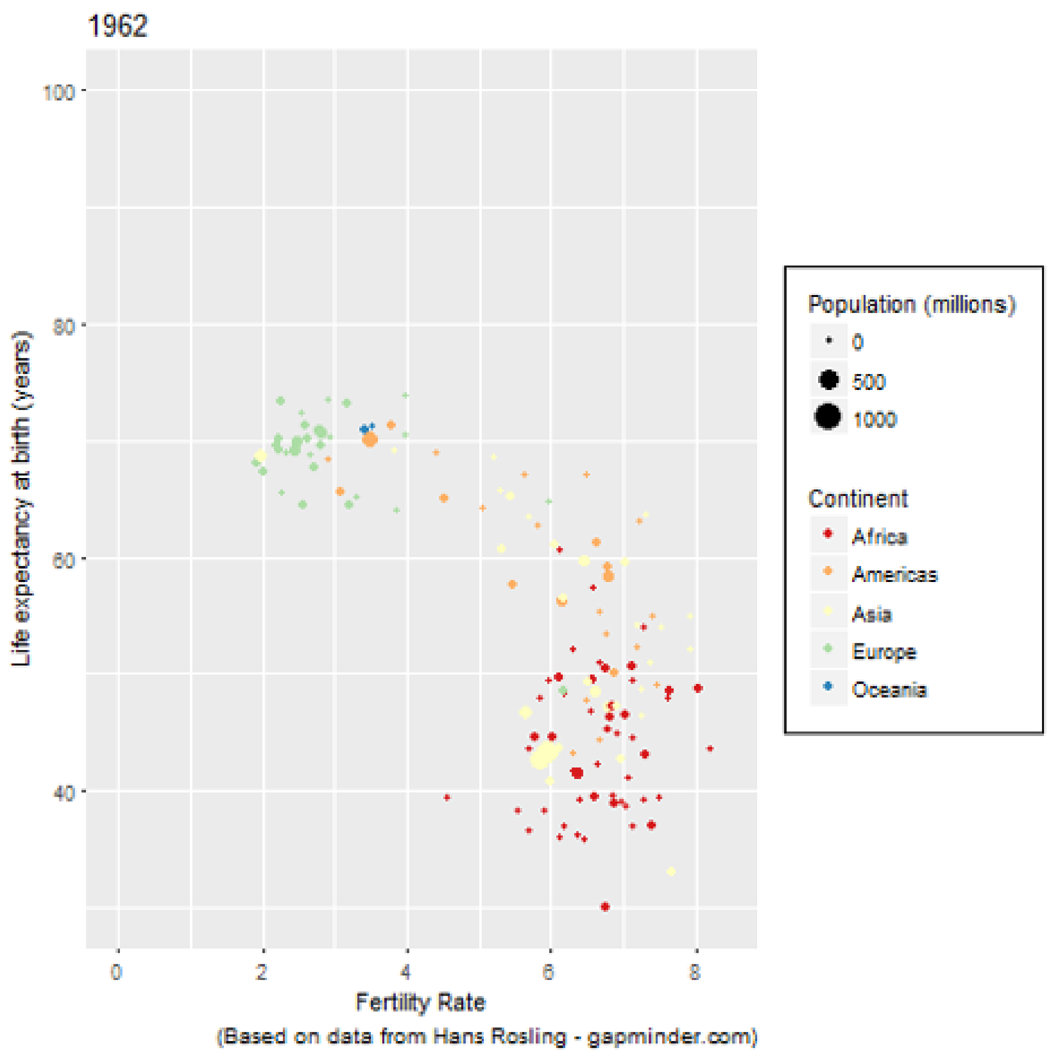
Developing Applications – Confidence Intervals



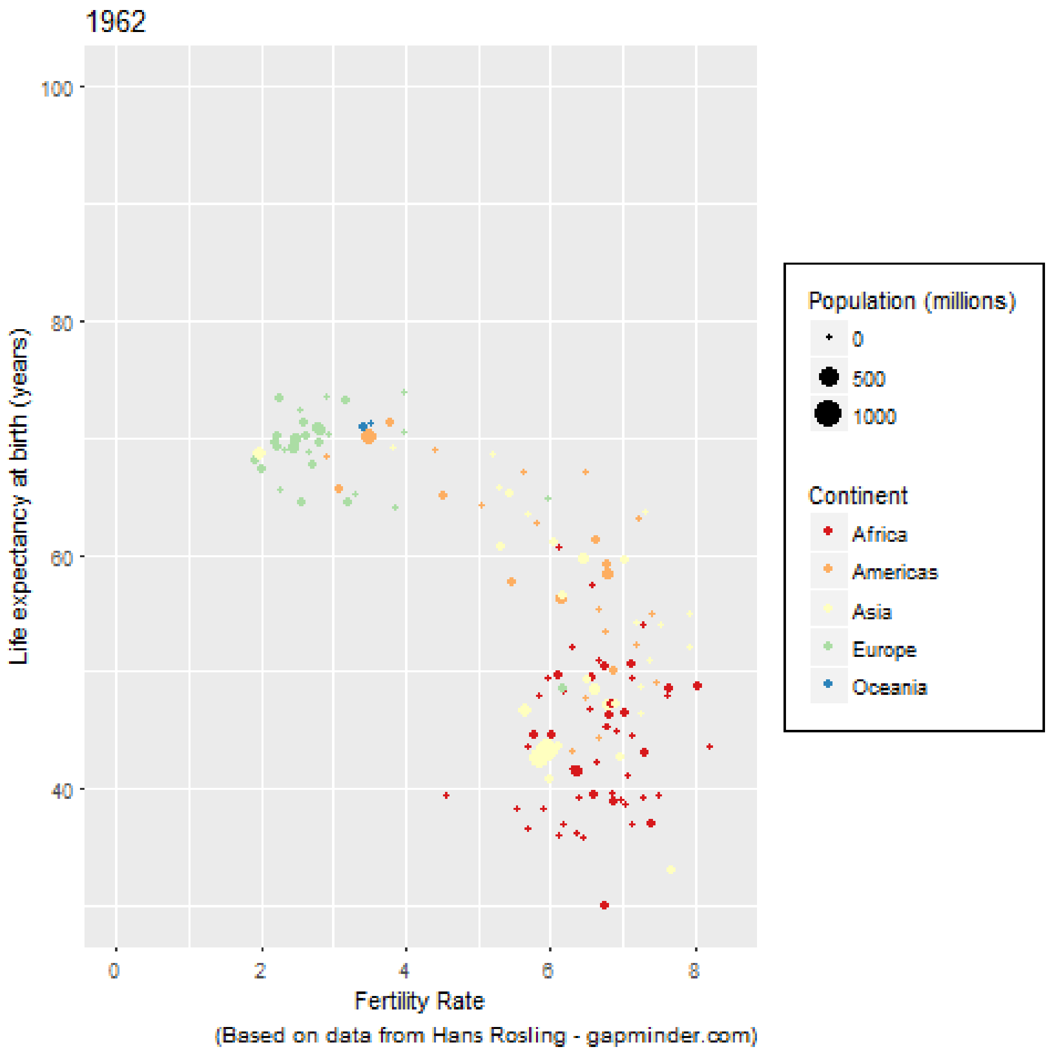
Developing Applications – Interactive Charts

Source: IFOA's Data Visualisation Working Party (https://dataviz-wp.blogspot.com/)

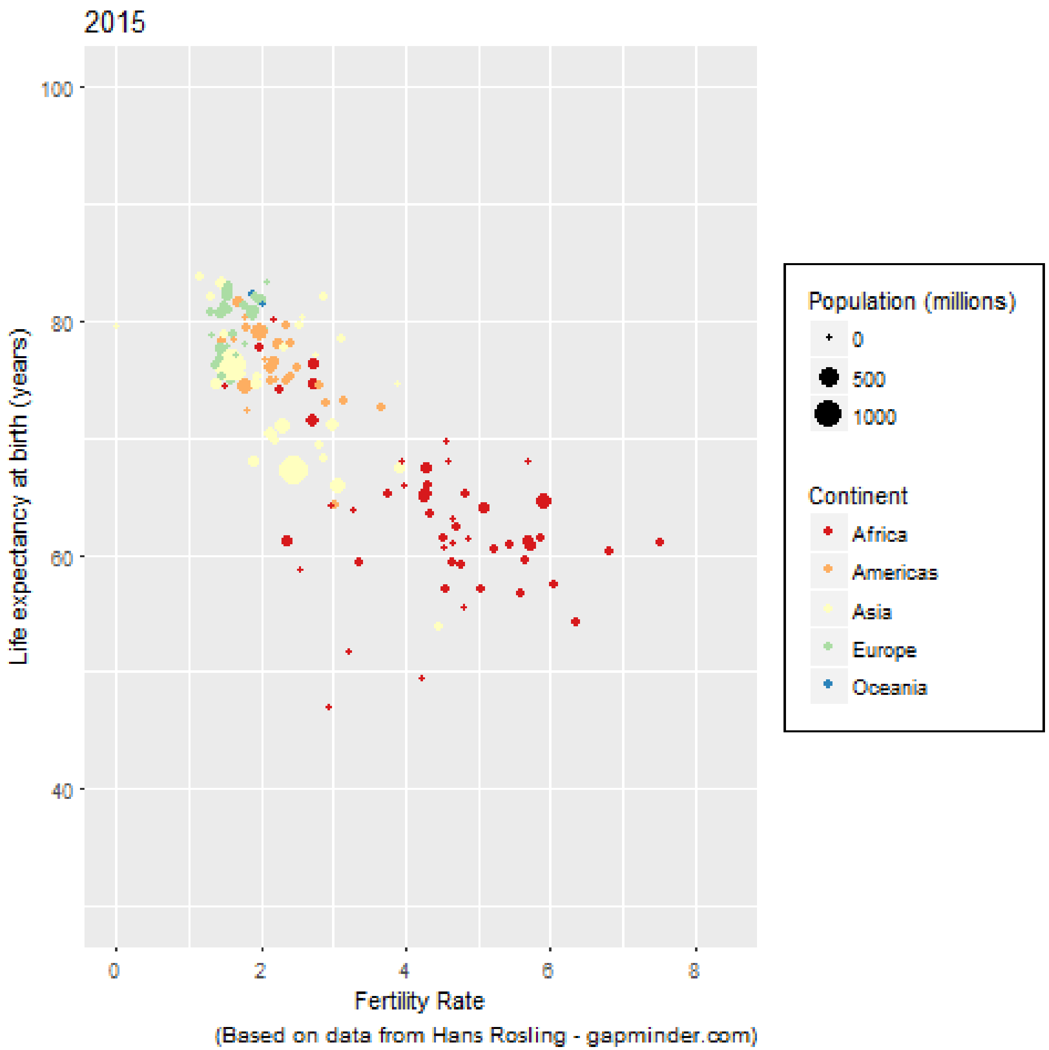
Developing Applications – Animated Charts



Developing Applications – Animated Charts



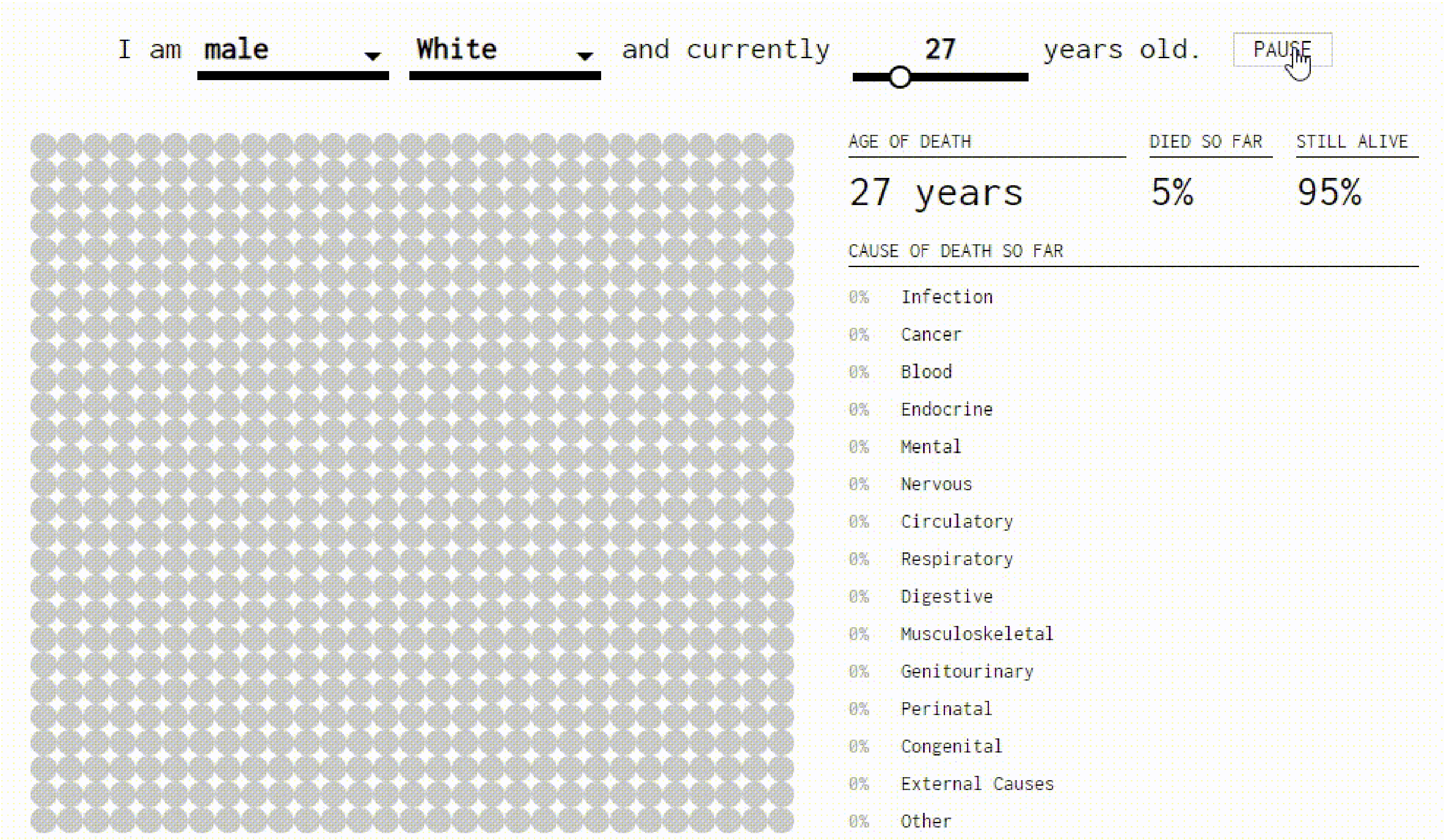
Developing Applications – Animated Charts



Developing Applications – Interactive Charts

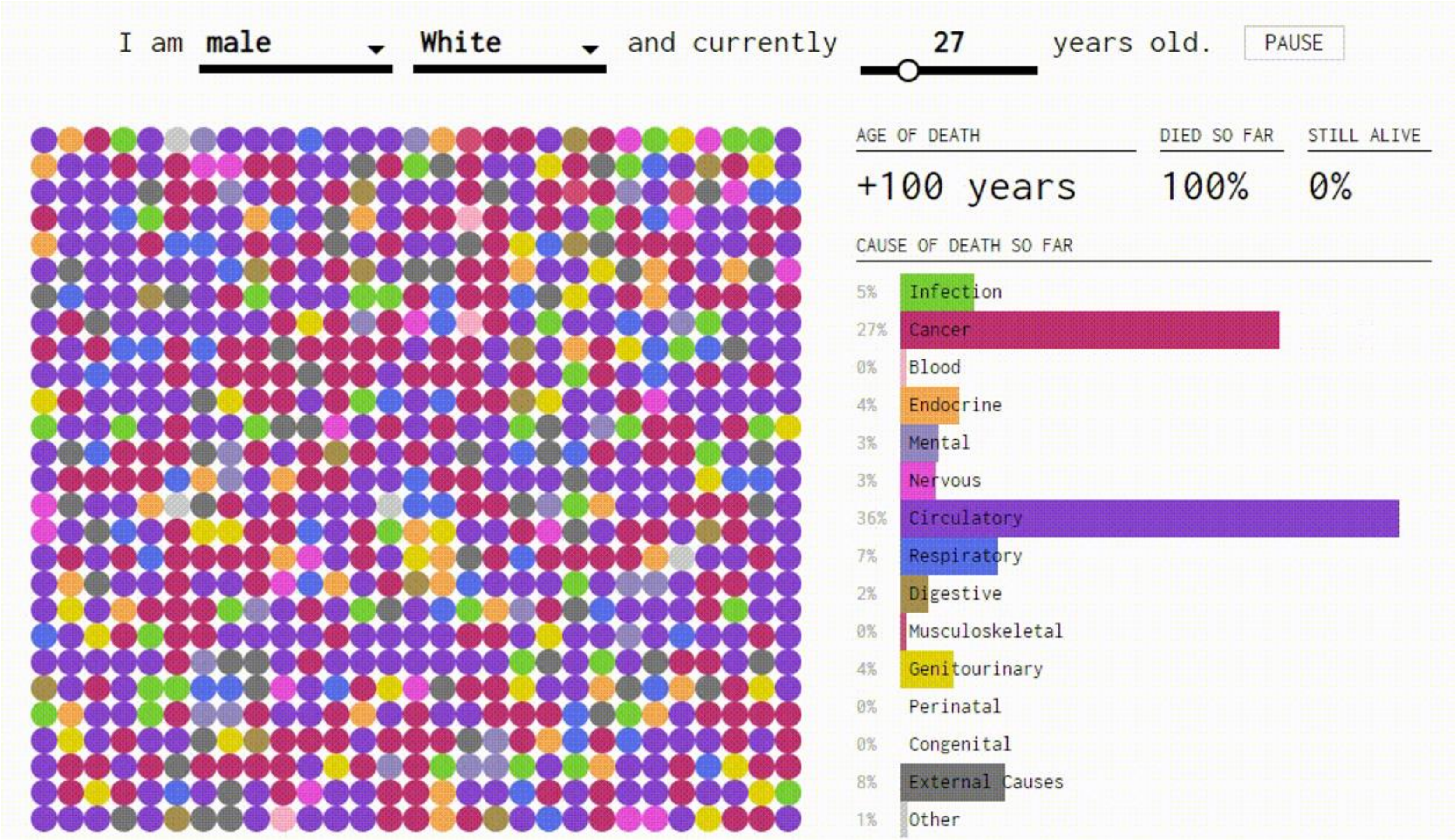
Source: https://flowingdata.com/2016/01/19/how-you-will-die/

Developing Applications – Interactive Charts



Source: https://flowingdata.com/2016/01/19/how-you-will-die/

Developing Applications – Interactive Charts



Source: https://flowingdata.com/2016/01/19/how-you-will-die/

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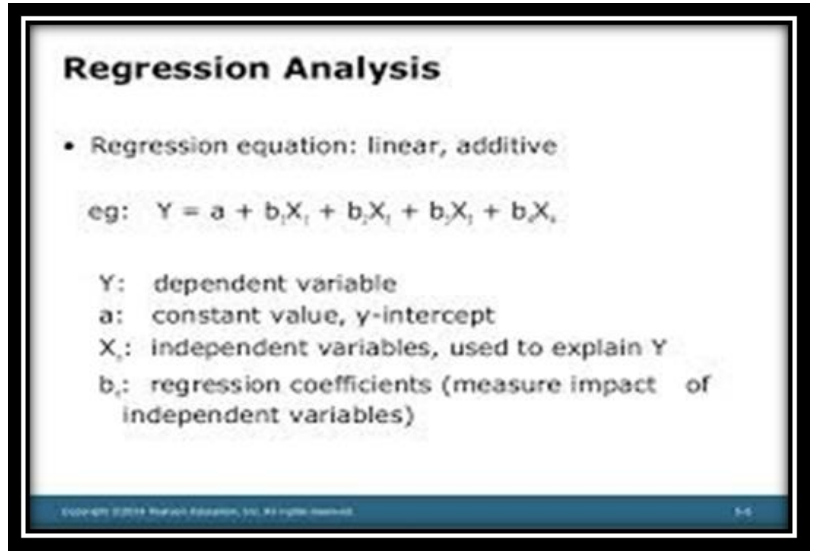
Data Science
Advantages in Lapse Analysis

Aisling Bradfield

GLM for Lapse Analysis

- Generalised Linear Model Regression
  - Poisson distribution
  - Quasi-families
  - Negative Binomial
  - Zero inflated models
  - Tweedie
- Log link function



- Choose the factors explaining lapse variation (X)
- Calculate a co-efficient (b) for each possible option for each factor and an intercept (a)
- Test significance of various factors

Potential drivers of Lapse Behaviour

Issue Year

Duration

Single V Joint

Calendar Year

Product Type

Standard V Rated

Smoker status

Distribution Channel

Issue Age

Postcode

Sum Assured

Commission

Gender

Interaction Terms

- Model all possible variables
- Test variables for significance at a 99% confidence level
- Understand the relationship between variables

Variable	Estimate	Exp(Estimate)	P Value
Gender			
Male	0.007	1.01	0.0969
Female	0	1.00	.
Issue Age			
18-29	0	1.00	.
30-39	-0.4147	0.66	<.0001
40-49	-0.4305	0.65	<.0001
50-59	-0.3077	0.74	<.0001
60+	-0.2329	0.79	<.0001
Smoker			
Smoker	0.9548	2.60	<.0001
Non-smoker	0	1.00	.

Smoker & Duration Group		Estimate	Exp()	P Value
Smoker	dur01-05	0	1.00	.
Smoker	dur06-10	-0.2785	0.76	<.0001
Smoker	dur11-15	-0.5009	0.61	<.0001
Smoker	dur16+	-0.6659	0.51	<.0001

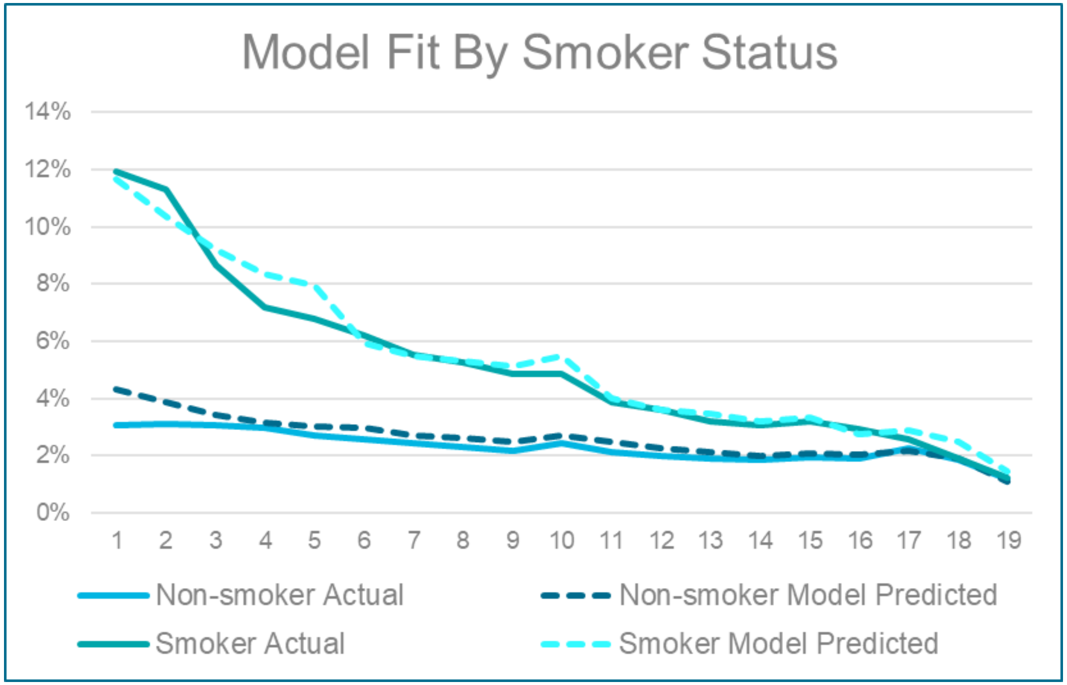
Not significant at 99%

Lapse are higher at younger ages

Interaction term captures smoker pattern

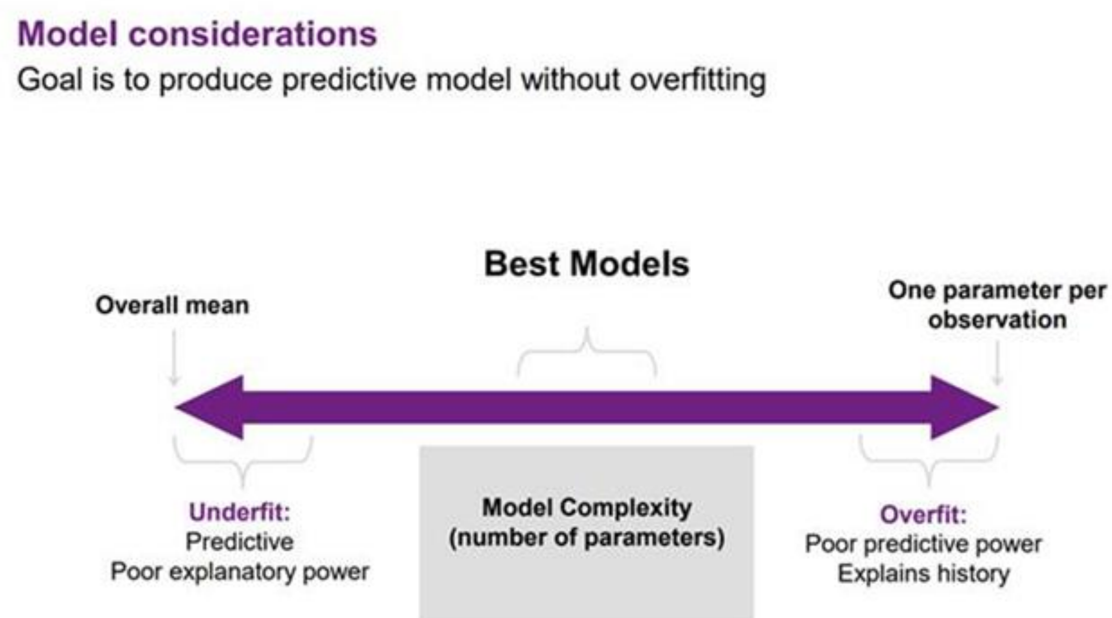
Modelling interactions

- Hold-out data for cross-validation
- Review model results for the fit to actual experience by different splits.



- See how the model captures the interaction between duration & smoker status

Model Refinement



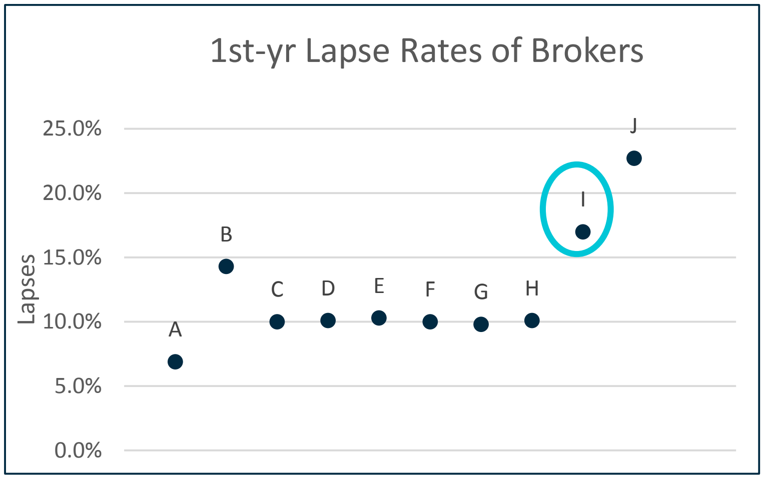
- Compare statistical model fit using Akaike information criterion (AIC) and Bayesian Information Criterion (BIC)
  - the model with the lowest AIC/BIC is the best fit.
  - If adding an additional variable does not reduce AIC/BIC, the variable does not add further explanation of the lapse rates.

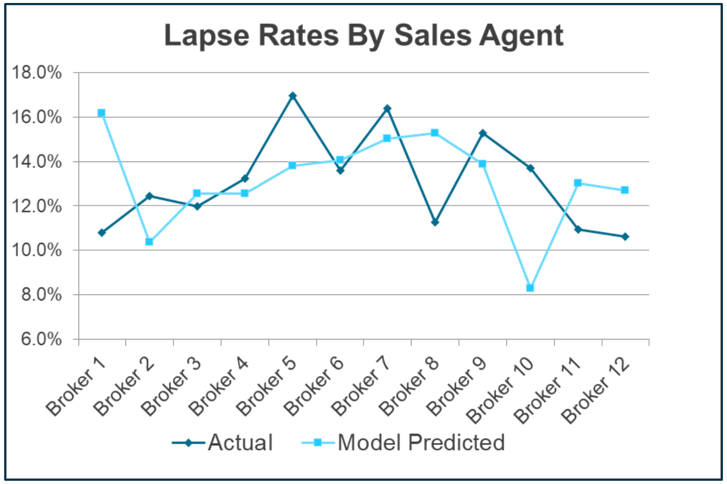
Using the Lapse Model

- Set assumptions
  - Predictive model provides a full set of lapse rates
- Build into model code
  - Regression equation instead large lapse rate tables
- Review lapse experience
  - Check actual to model predicted at each lapse study
  - Build Confidence Interval
- Manage persistency
  - Insights from modelling
  - Benchmark for comparison

Residual Variation

- Comparing persistency between sales agents





Comparing lapse rates:

- Differences in lapse experience may be attributed to business mix
- e.g. B & J write a lot of rated business, A only writes standard
- What can we say about Broker I?

Compare lapse Vs model predicted:

- Model accounts for other sources of difference
- Brokers 1 and 8 have better than expected persistency while 2 and 5 are showing higher actual lapse rates
- Benchmarking against predicted provides a clearer comparison

Conclusion

- One Model Concept
  - One version of best estimate, no silos
  - Integrated solution for traditional financial reporting and analytics platforms
  - Powerful visualisations to help assess your data

- Generalised Linear Modelling
  - Identifying key drivers for Lapses
  - Multivariate Analysis
  - Residual variation insights

Society of Actuaries in Ireland

Questions

Life Re Forum, 16th April 2019

Appendix: One Model Concept – Case Study

- **Dedicated Experience Study Team**

“Improve the Experience Study delivery time, implement advanced analytics, reduce gaps to financial results and Model Study.”

  - Separate models for valuation (RAFM) and experience analysis (SQL)
  - Large and complex models: E’s are not completely consistent
  - RAFM already has infrastructure to code q x exposure logic using values that are policy specific

- **Solution:**
  - Implement experience analysis logic into the valuation model
  - See Appendix for Changes Required & Other Considerations
  - Consistent best estimate
  - One model run, several bases and output for policy and calendar year

Appendix: Case Study

- **Modest Changes Required:**
  - New input fields added:
    - Status (Live, Death, Lapse, etc.)
    - Exit Date
  - Death rates and lapse rates updated for EA functionality:
    - Actual and Expected calculations
    - Daily exposure (if required)
    - Calendar year and policy year functionality
  - New columns for:
    - Additional bases (rather than additional submodels)
    - Actual and expected amounts

Appendix: Case Study

- **Complications:**
  - Changing Net Amount at Risk (NAR) structure
  - Changing policy details
  - …Overcome by having multiple policy records and start and end dates

- **Key Benefits:**
  - Consistent best estimate
  - Input file in same format
  - One model run, several bases and output for policy and calendar year