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SECTION COLLOQUIUM 2019

THE MODERN ACTUARY - CHALLENGE • INFLUENCE • LEAD

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CTICC

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ACTUARIAL SOCIETY OF SOUTH AFRICA

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RESERVE AUTOMATION FRAMEWORK

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Hosted by ACTUARIAL SOCIETY OF SOUTH AFRICA
SECTION COLLOQUIUM 2019

RESERVING FOCUS

- Significant degree of uncertainty and complexity associated with Insurance and Health Liability estimates due to the complex and randomness of the claims process – incidence, reporting, settlement.
- Reserving practice is not just the selection of method, but also the management of data, the application of judgement and peer review.
- Many reserving techniques available. Important to consider the type, level and reliability of data available, the features of the portfolio and how best to identify and model the loss drivers.
- It is not enough for Boards to be presented with the actuarial "best estimate" view of reserves. To make informed decisions, actuaries and Boards need to understand the assumptions and methods relied upon and the sensitivity of – and potential volatility in – the reserves.

PROCESS INDUSTRIALISATION

Three themes are influencing the way we need to work

1) The world is becoming more complex, and more complex in modelling requirements.

2) Deadlines for sharing information around a business and for reporting information to external stakeholders are shortening.

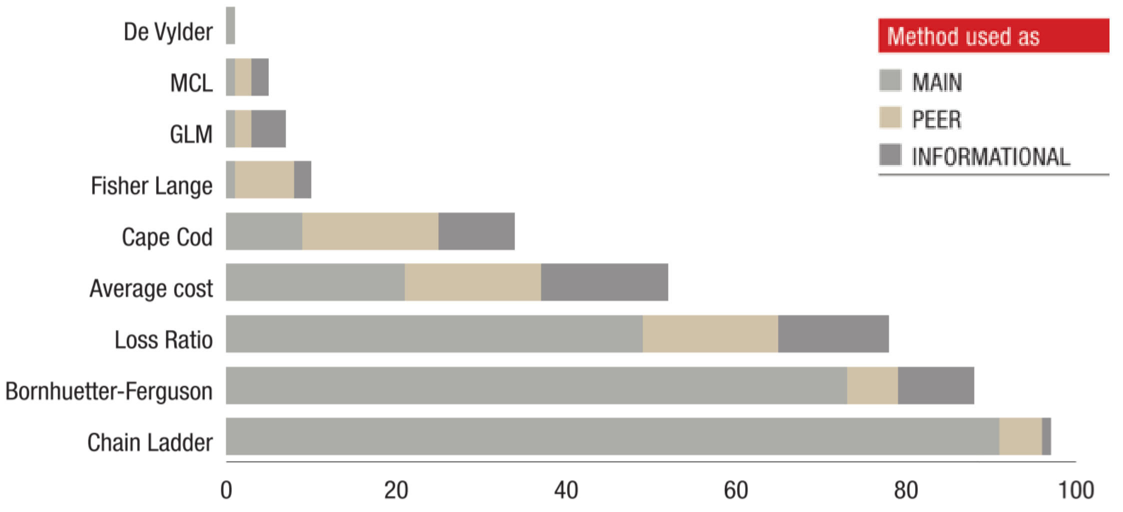
3) Technology and processing power available to improve the way we work and our expertise needs to keep up with this. Tech to augment what we do.

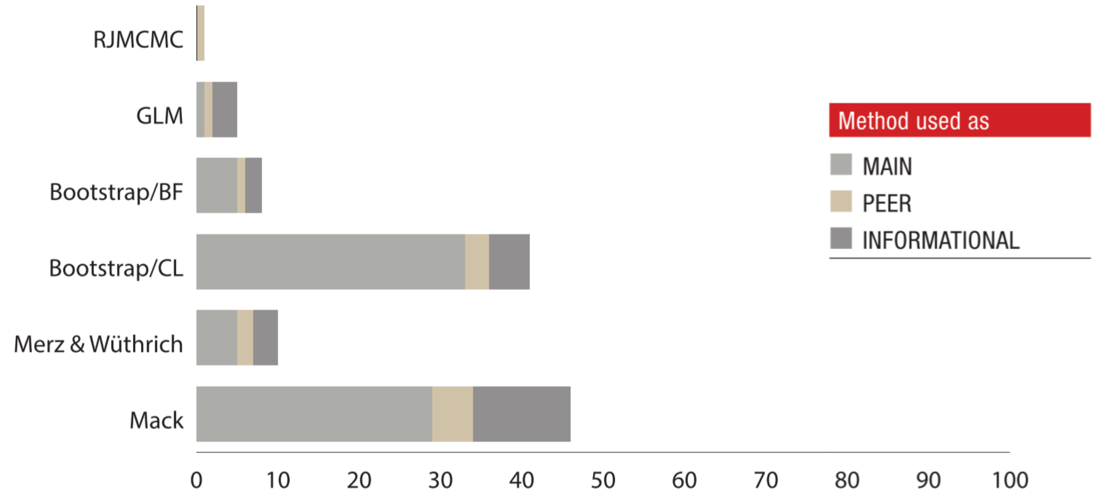
SESSION OBJECTIVES

This session will:

- Highlight some of the reserving methods used in the market beyond the basic Chain Ladder and Bornhuetter-Fergusson
- Demonstrate a Framework for Automation and validation
- Diagnostics – how do you know when machine gets in wrong
- Show you a case study of method performance and measurement over a 20 year history of a bodily injury liability reserving class.

ASTIN 2016 SURVEY METHODS USED





Range of methods available, but few methods used.

Graphs shows global responses, table shows South Africa specific:

	Unused
Percentage	86%
Loss ratio	57%
Chain ladder	9%
Bornhuetter-Ferguson	27%
Cape Cod	86%
Average cost	52%
De Vylder	100%
Fisher-Lange	100%
GLM	100%
Munich Chain Ladder	100%
Market-based std dev	91%
Internal calibration	95%
Mack	57%
Merz & Wüthrich	90%
GLM	100%
Bootstrap / CL	39%
Bootstrap / BF	90%
RJMCMC	100%

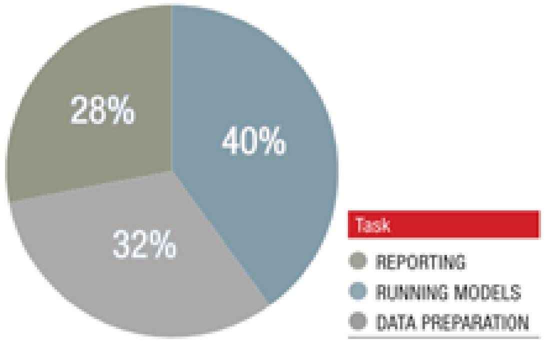
ASTIN 2016 SURVEY RESOURCES USED

dyna·mo ANALYTICS

If so many methods available, why such a constrained response?

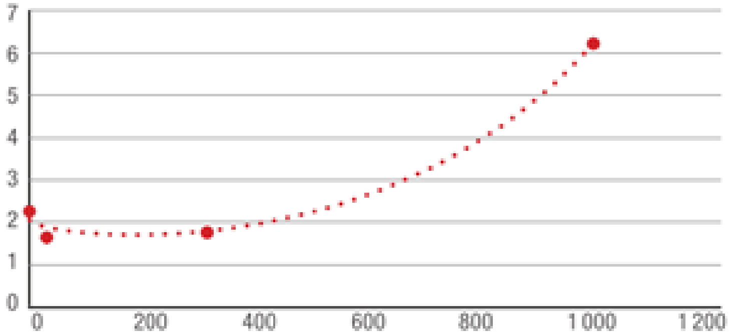
- Resource constraints, lack of appropriate software or systems which requires lots of resources on data prep.
- Tools used not conductive to Automation. Almost 40% of companies perform reserving modelling exclusively in Excel. Specialist tools focused only on Actuarial Technical method, not process and validation.
- SA 35% on data prop and 28% on reporting – only about 1/3rd of time spend on Analysis and Modelling

Resources split



Running model is the main task for actuaries for most insurers (40%). Then comes data preparation (32%), and reporting (28%).

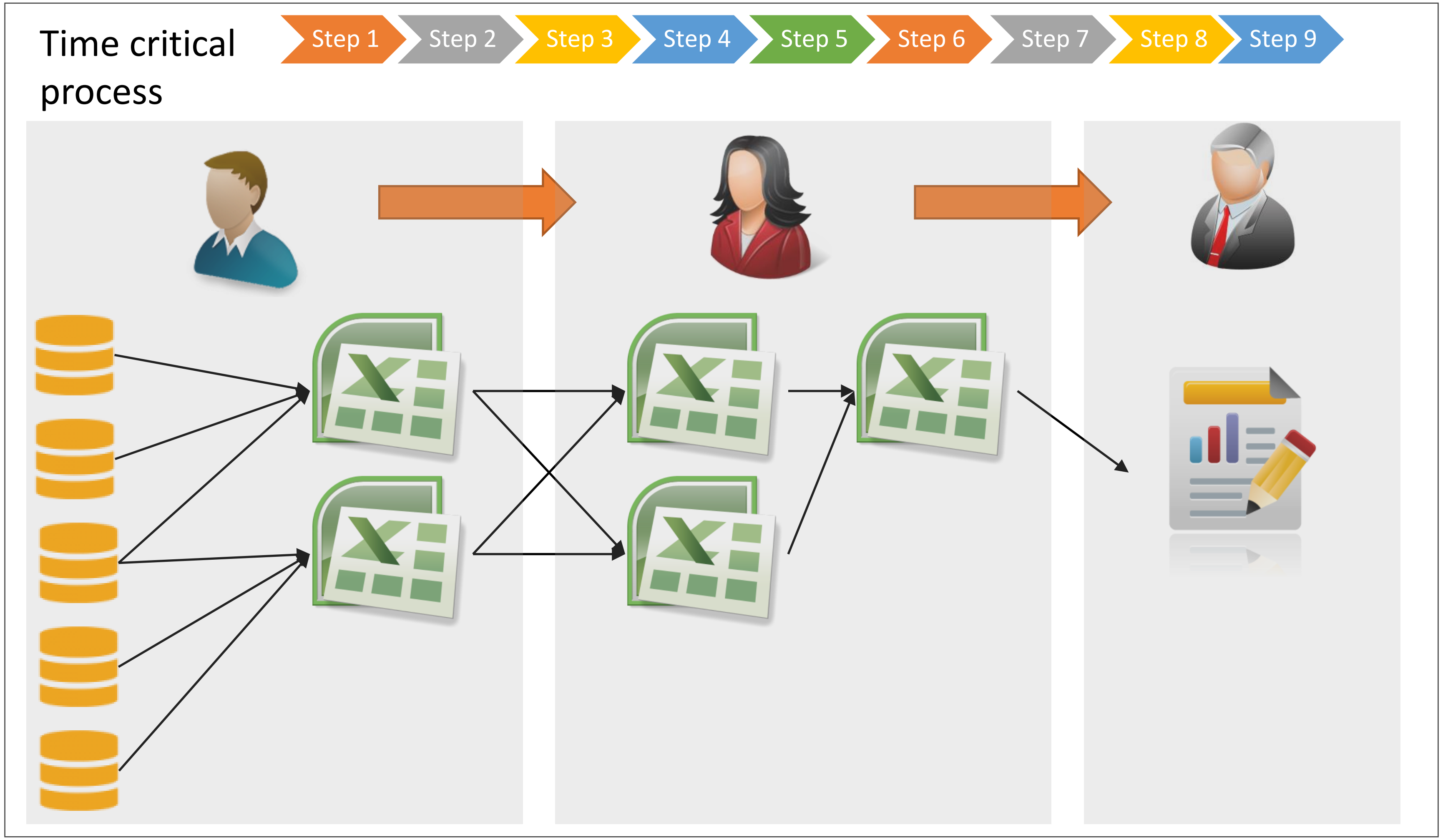
Average number of companies vs companies size



The number of actuaries required to make a reserving exercise seems to be constant around 2, until the company size exceeds USD 500M.

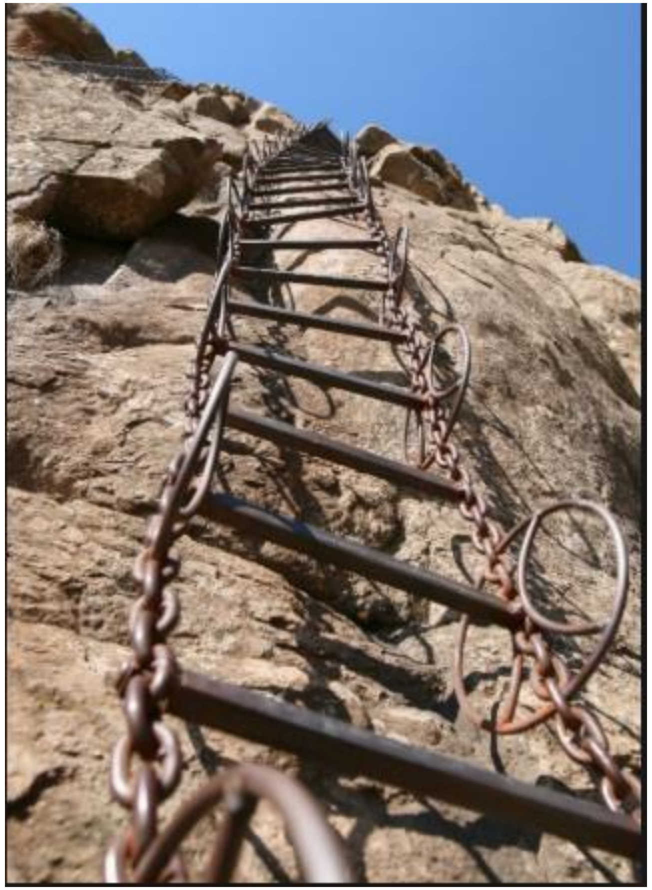
TYPICAL PROCESS

Data manipulation, fixing formulas, updating links….



…no time to meaningfully consider the appropriateness of methods or assumptions, or to conduct sensitivity testing, or extend use of other methods.

TYPICAL ANALYSIS APPROACH



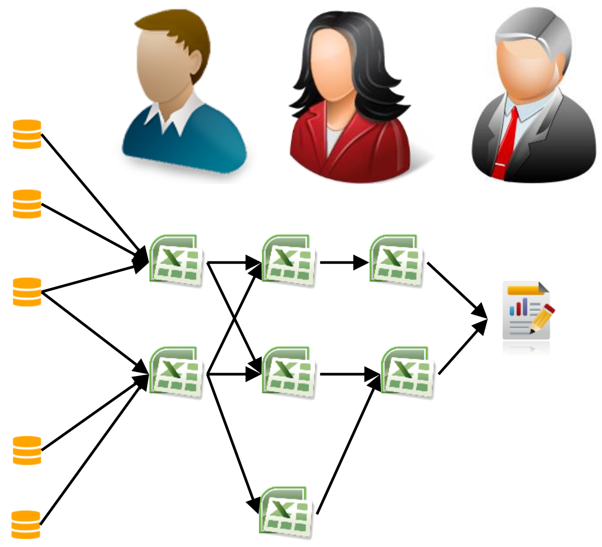
FRAMEWORK FOR AUTOMATION

1. Think Rules based, not link ratio based.
2. Automate the data manipulation, segmentation and adjustment process
3. Use a platform that can allow for Script or Code based selections
4. Allow for wide number of methods
5. Segment highly volatile claim types and model stochastically, e.g. special treatment of large claims.
6. Know limitations of methods, and set 'selection rules' to accommodate them
7. Once rules are set let the process run 'hands free'
8. Diagnostics and Visual tools, A vs E, Back-Testing, Residuals, Graphs
9. Apply actuarial judgement, smoothing and prior selection refinement.

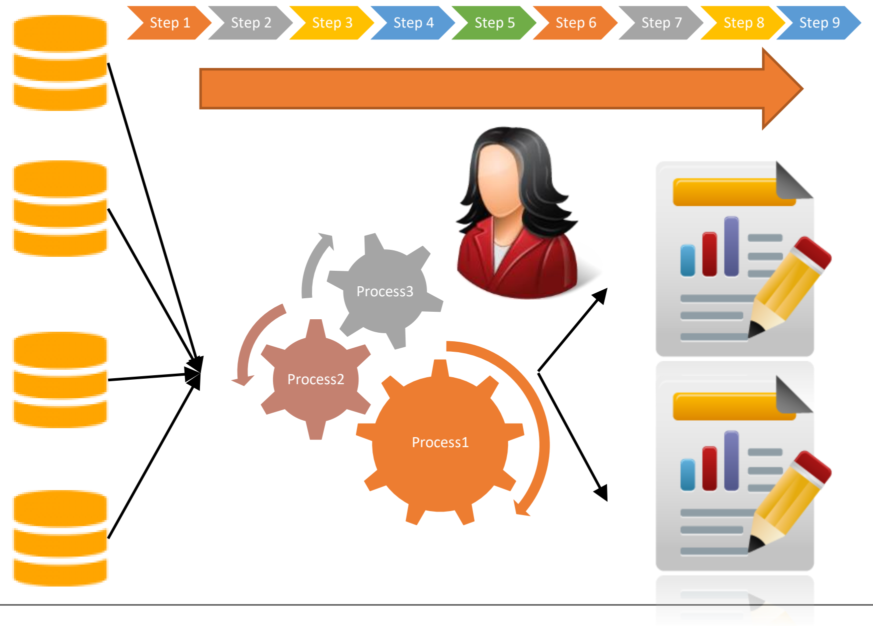
INDUSTRIALISATION CODIFY MECHANICS

Technical Process Industrialisation

Model design and parameterisation



Time critical process - environment fit for purpose



- Repeatable processes are defined in a coded environment.
- Securing data flow from process to process as well as securing calculation engines.
- An “actuary-in-a-box” approach to parameterisation of reserving data.
- Gives a first cut that can then be improved upon by experts

RESERVING TECHNIQUES

Chain Ladder and **Bornhuetter-Ferguson (BF)** clearly favoured across the globe, with Average cost per claim methods.

Focus on Triangle-based techniques, range of methods very useful to understand underlying trends

- **Projected Payments per Claim Incurred (PPCI)** – paid in each development period as a % of ultimate claims reported – Ultimate numbers reported and paid per development period
- **Projected Payments per Claim Finalised (PPCF)** – projects average cost of claims finalised in each development period – Finalised numbers projected per development period AND paid amounts per development period
- **Projected Case Estimates (PCE)** – Project movements in case estimates, and payments as % of such case estimates per development period.
- **Benktander** – Iterative BF method, where posterior from previous analysis used as prior.
- **Munich Chain Ladder** – regression on paid to incurred relativities
- Other methods such as Stochastic Case Estimation (SCE) or Frequency / Severity good to consider as can supplement with other variables other than delays in settlement.

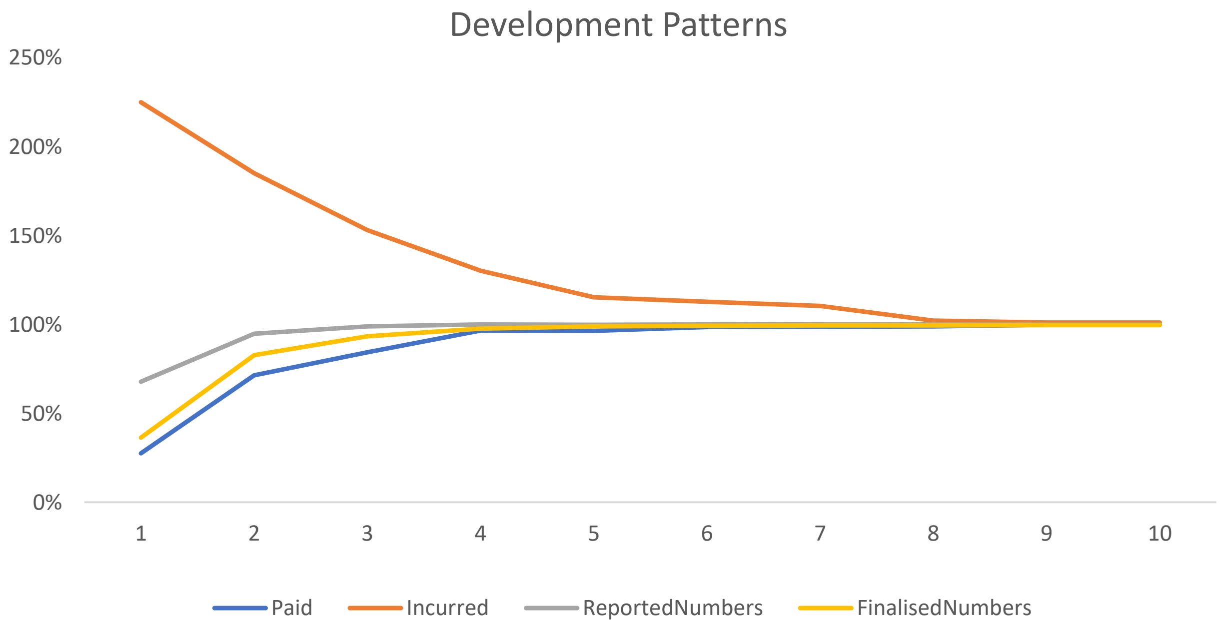
TECHNIQUE LIMITATIONS

Method	Limitation
Chain Ladder Paid	Assume stability in historic settlement rates and amounts. As its proportional to development to date can be very volatile for immature years.
Bornhuetter-Ferguson	Prior assumption may not be appropriate, but full weight given to future development. BT method would increase credibility on experience over time.
Chain Ladder Incurred	Follows trends in data without identifying the cause and can lead to erratic results unless those trends are stable. Assume case estimates either reliable or stable in approach.
PPCI	Can be particularly unreliable in the tail when there are only a few claims open. A PCE more appropriate in the tail. Basic model not allow for case estimation.
PPCF	Number of claims finalised can be unstable, and sensitive to movements in number of open claims
PCE	Not really suitable for recent cohorts of long tailed liabilities, better used in the tail.
Munich CL	Regression on paid to incurred ratios so will always project between 2 methods. Management may feel 'exposed' to allow large savings relative to case estimates.

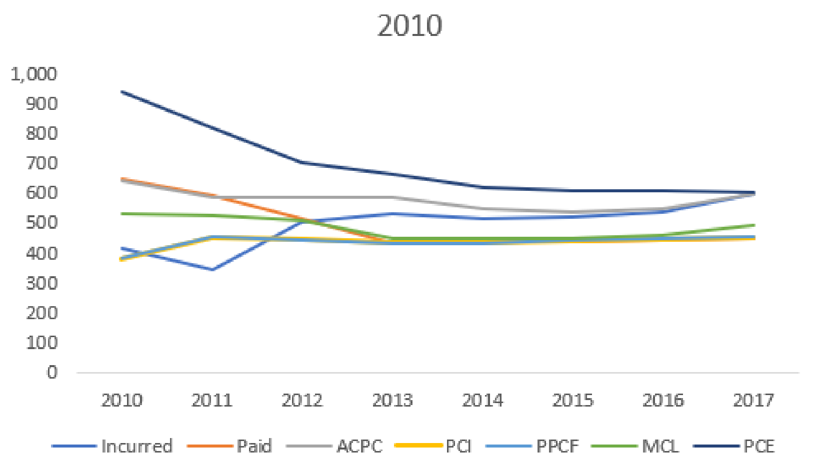
RESERVING METHOD RESULTS COMPARISON

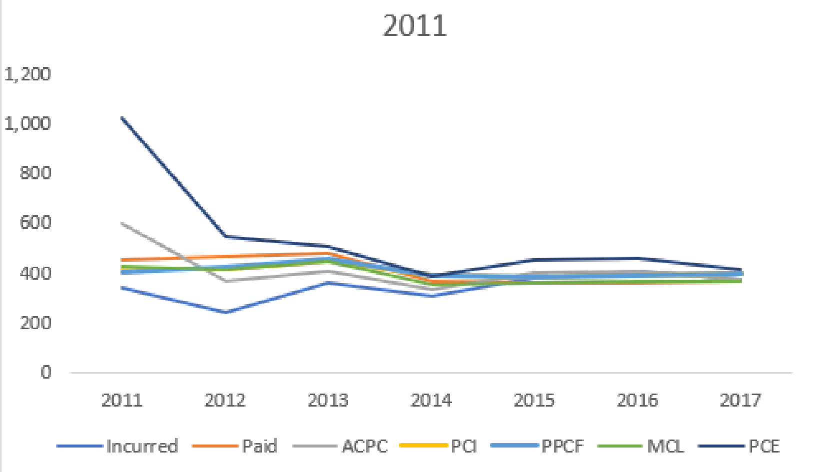
Case study: Bodily Injury Portfolio of risks. Applied 6 methods to compare.

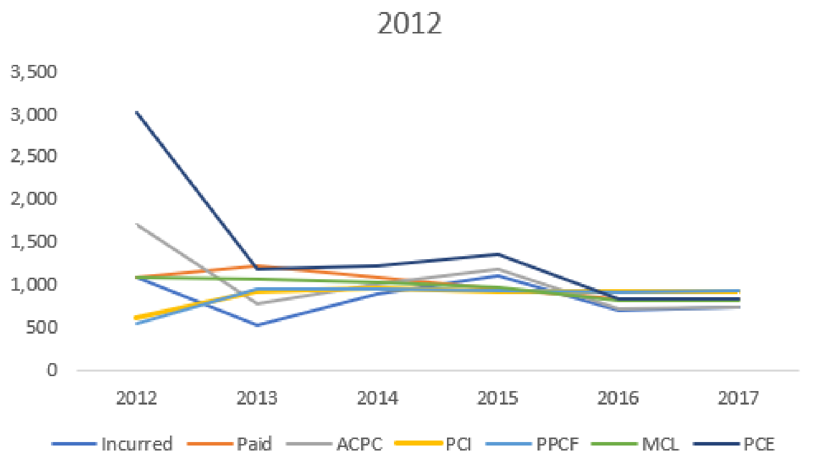
- 20 year claims history of a stable portfolio
- Reasonable consistent development process
- Following shows statistical projected ultimate for each accident year, at different points in time as the cohort matures.

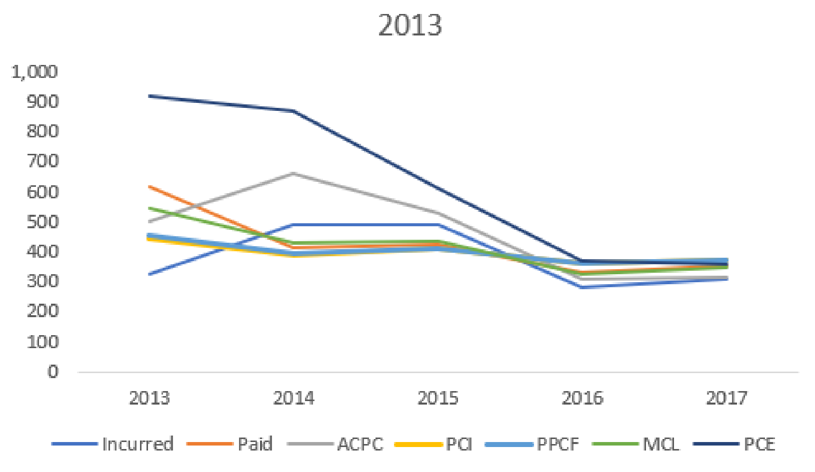


ULTIMATE LOSS DEVELOPMENT PER METHOD





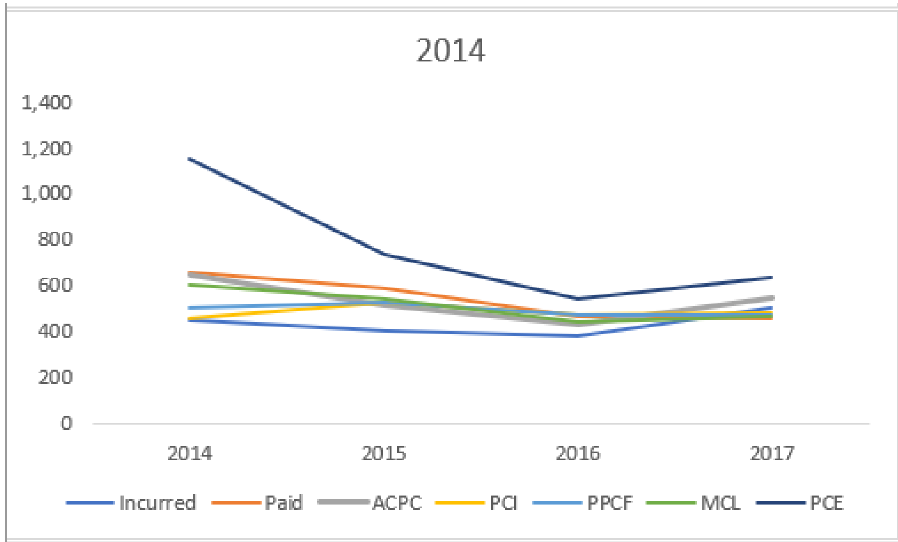


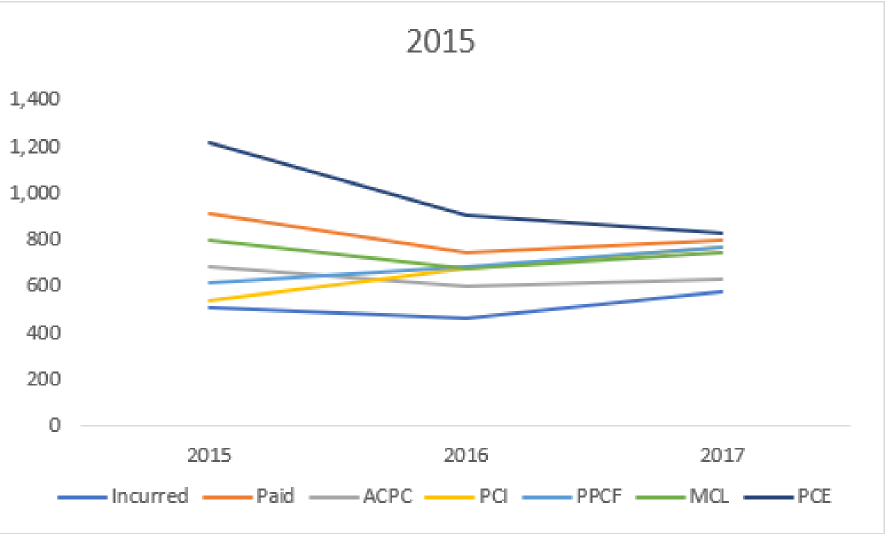


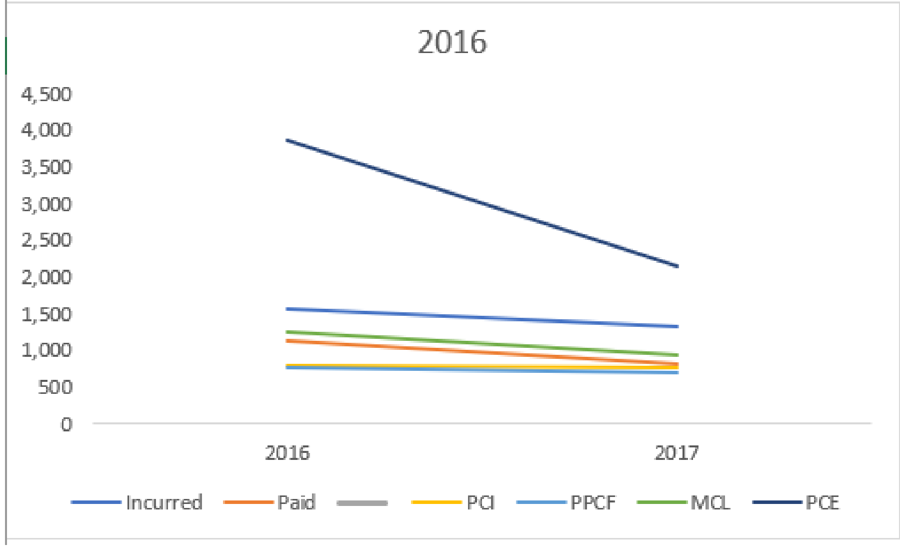
Choice of GO-TO method might be the most reliable, but change in relationship with other methods may tell you something important.

Paid / MCL seems to be more credible in early periods, PCE or incurred better in later periods.

Case estimate based methods better in later periods







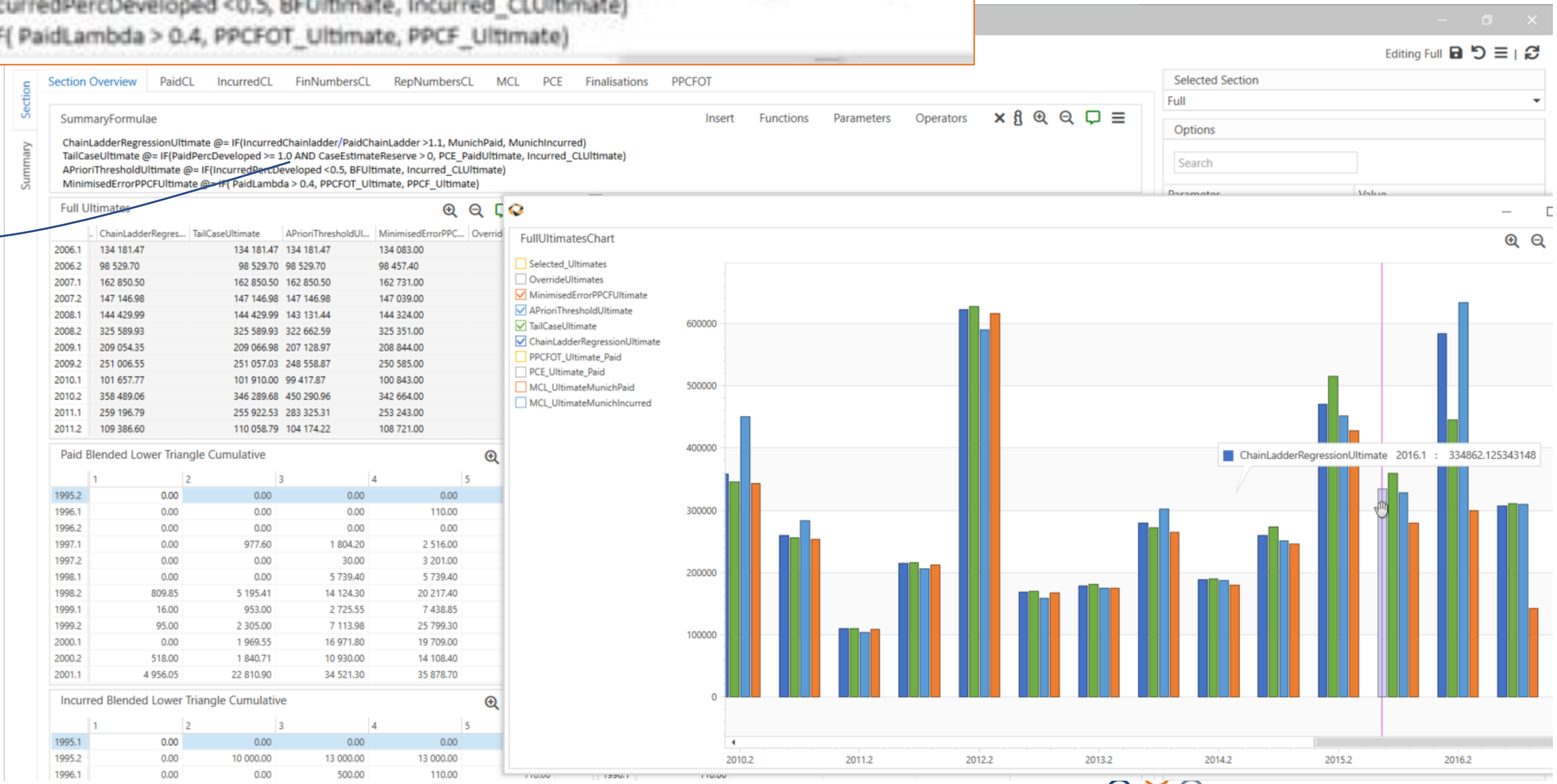
Incurred Ultimate projection has consistently been lower than other methods in early development. What does this mean for 2016 selection?

Once assessed your algorithm need to codify it, to make selections based on ratio / relativity of method results.

RULES BASED RESERVING SELECTION RULES

ChainLadderRegressionUltimate @= IF(IncurredChainladder/PaidChainLadder >1.1, MunichPaid, MunichIncurred)
TailCaseUltimate @= IF(PaidPercDeveloped >= 1.0 AND CaseEstimateReserve > 0, PCE_PaidUltimate, Incurred_CLUltimate)
APrioriThresholdUltimate @= IF(IncurredPercDeveloped <0.5, BFUltimate, Incurred_CLUltimate)
MinimisedErrorPPCFUltimate @= IF(PaidLambda > 0.4, PPCFOT_Ultimate, PPCF_Ultimate)

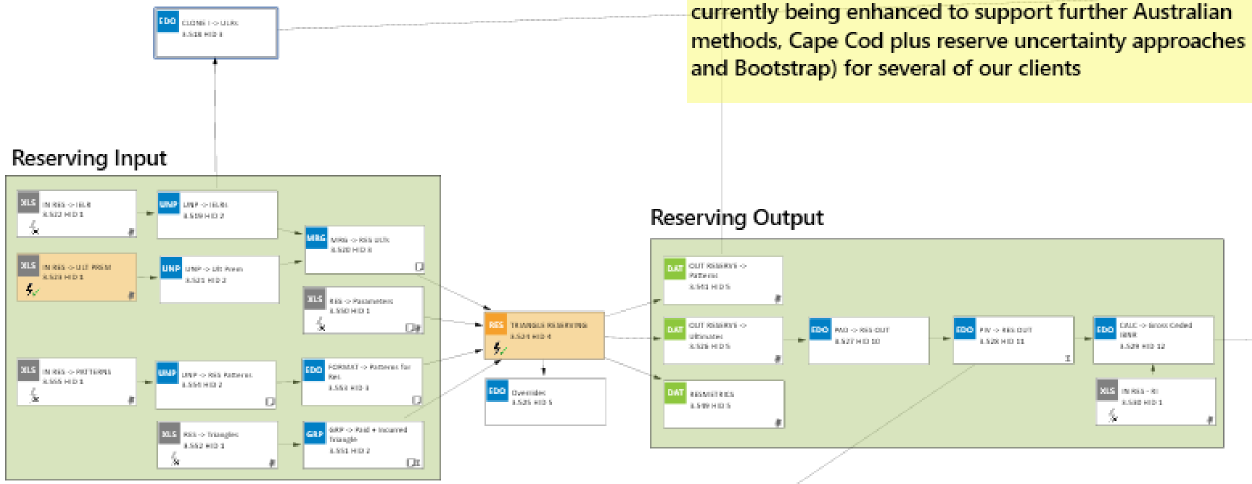
Initial selections can over time be automated as well. Opens up for AI.



NOW PRESS PLAY

RESERVING

The Reserving Platform also supports the Munich CL and is currently being enhanced to support further Australian methods, Cape Cod plus reserve uncertainty approaches (Mack and Bootstrap) for several of our clients

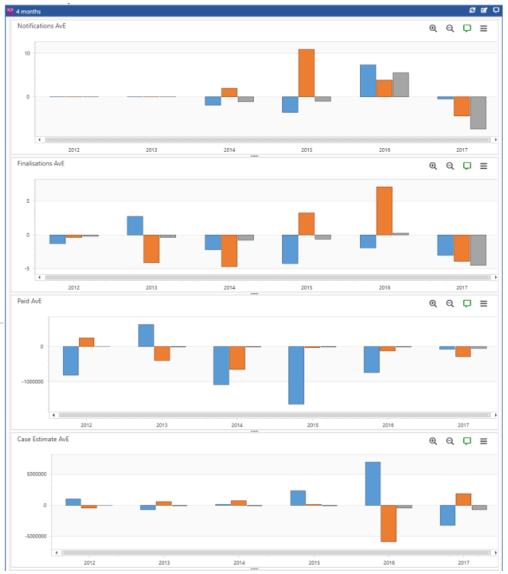


GRP --> Reserves by Class

Class	Entity	Paid	Outstanding	Ultimate	IBNR
AVIATI	BDA	58,728.48	5,489.28	66,198.79	1,981.04
CASLTY	BDA	5,033.67	8,080.60	36,604.62	23,490.35
ENGOFF	BDA	319,387.31	51,642.24	378,109.88	7,080.32
ENGONS	BDA	182,095.00	100,044.39	287,721.49	5,582.10
ENGINE	BDA	26,894.13	17,488.96	56,112.43	11,729.34
FINANC	BDA	49,786.34	16,128.09	79,597.85	13,683.42
MARINE	BDA	197,000.84	5,579.47	201,680.71	-899.60
POLVIO	BDA	23,489.64	14,965.91	49,291.98	10,836.43
PORTER	BDA	71,109.35	62,785.12	148,544.06	14,649.59
PROPTY	BDA	136,544.13	13,942.04	154,250.08	3,763.91
REINSU	BDA	68,017.53	13,596.01	84,893.35	3,279.81
AVIATI	SYN	41,948.91	3,920.91	47,454.86	1,585.04
CASLTY	SYN	3,595.48	5,771.86	29,122.11	19,754.78
ENGOFF	SYN	228,133.79	36,887.32	271,216.39	6,195.28

GRP --> Reserves by Entity

Entity	Paid	Outstanding	Ultimate	IBNR
BDA	1,138,086.41	309,742.13	1,543,005.23	95,176.69
SYN	812,918.06	221,244.38	1,113,784.75	79,621.51

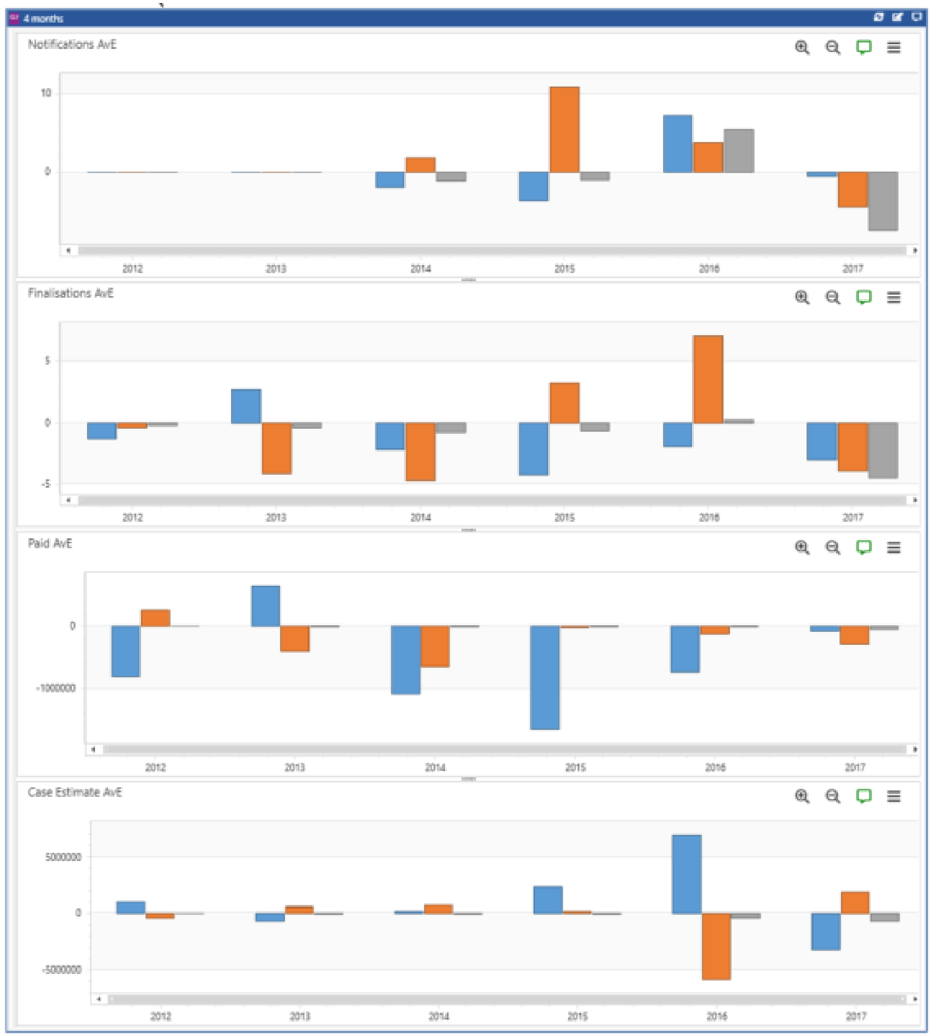


DIAGNOSTICS REVIEW OF RESULTS

Actual vs Expected and Back Testing:

- Dashboard of A vs E by method gives insight into over / under projections
- Based on previous selected pattern – assess how previous assumptions perform against experience.
- Based on newly selected pattern – back-test new assumptions as driver of change in ultimate claims projection.
- Case Position lower than expected relating to number of finalisations greater than expected

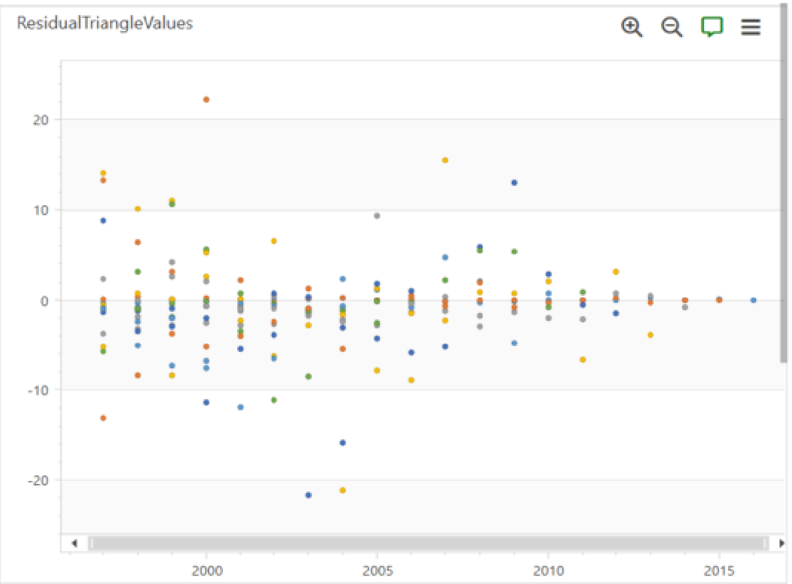
DIAGNOSTICS A vs. E Time Periods Considered



DIAGNOSTICS RESIDUAL GRAPHS

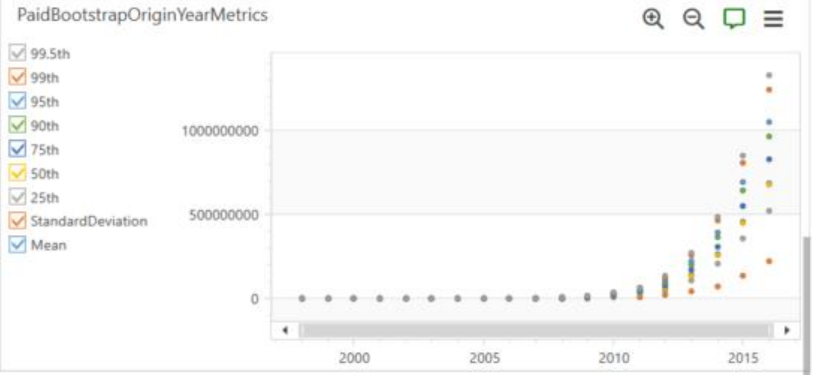
Residual Triangle Values

	1	2	3	4	5	6
1997	-0.32	0.15	-3.76	14.05	8.78	-5.76
1998	-0.30	0.31	-3.15	10.14	-3.48	3.10
1999	-0.19	0.10	-2.83	11.06	-2.93	-1.83
2000	-0.21	0.23	-2.50	5.51	-0.70	-0.23
2001	-0.03	0.03	-2.87	0.06	-0.86	-3.41
2002	0.11	-0.26	-2.73	-6.26	-3.91	-11.12
2003	0.06	0.21	-1.78	-2.88	-21.67	-8.55
2004	0.16	0.18	-2.10	-21.24	-15.94	-1.17
2005	-0.03	-0.19	-2.81	-7.87	-4.30	-2.55
2006	0.00	0.15	-1.37	-8.85	-5.84	-0.25
2007	-0.14	-0.17	-1.20	15.58	-5.15	2.16
2008	-0.25	-0.03	-2.97	0.82	5.96	5.55
2009	-0.15	-0.05	-1.41	0.81	13.08	5.33
2010	-0.03	-0.30	-1.99	2.02	2.83	-0.89
2011	-0.05	-0.04	-2.22	-6.71	-0.61	0.93
2012	-0.04	0.16	0.70	3.17	-1.50	
2013	0.19	-0.34	0.42	-3.83		
2014	-0.02	-0.08	-0.84			
2015	0.03	-0.09				
2016	0.00					



PaidBootstrap Origin Year Metrics

	2012	2013	2014	2015	2016
Mean	68,208,558	142,295,792	263,958,501	460,606,340	685,683,874
StandardDeviation	21,362,841	44,169,260	75,235,146	138,306,386	220,399,609
25th	52,691,469	110,261,032	210,648,934	359,123,812	522,607,403
50th	65,816,129	138,479,655	258,034,860	454,001,147	683,929,129
75th	81,670,698	170,341,394	312,008,960	552,833,475	829,526,722
90th	97,039,195	201,232,830	363,695,127	642,876,698	968,462,350
95th	106,278,224	220,203,919	397,690,700	696,338,567	1,054,386,185
99th	127,103,717	259,249,720	463,658,921	808,092,372	1,247,696,810
99.5th	135,837,734	276,881,324	491,007,769	854,342,843	1,332,413,567



Use projection residuals similar to GLM models

- Have a set of diagnostics and residual plots.
- Residuals of chose method but also of supporting methods.

Use stochastic ranges to determine if movement from **all** methods are within reasonable variance, e.g. within 75th or single Standard Deviation.

POTENTIAL TO IMPROVE

Should make use of Automation, Process industrialisation and Visual diagnostics to significantly improve actuarial practices and the value of actuaries in business decision making.

Let software do the heavy lifting so we can run the process faster, perform more methodologies, generate better metrics…

Automated reserving processes and automated parameter selection, including identification of model failure or adjustments to be made…

and consequently help businesses better **understand** their reserves and the movements in their reserves.

QUESTIONS

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