BRIDGING RESERVING AND BUSINESS STEERING
USING AI ASSISTANCE

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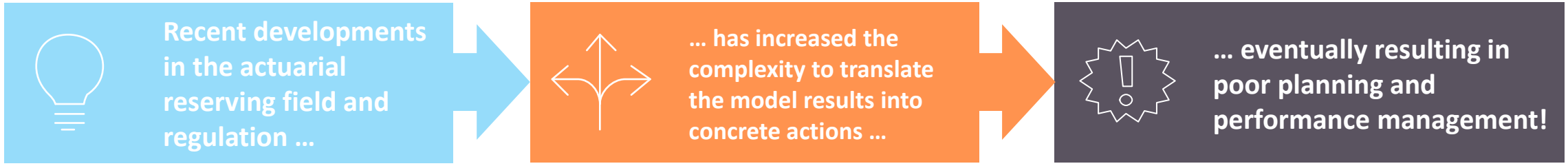
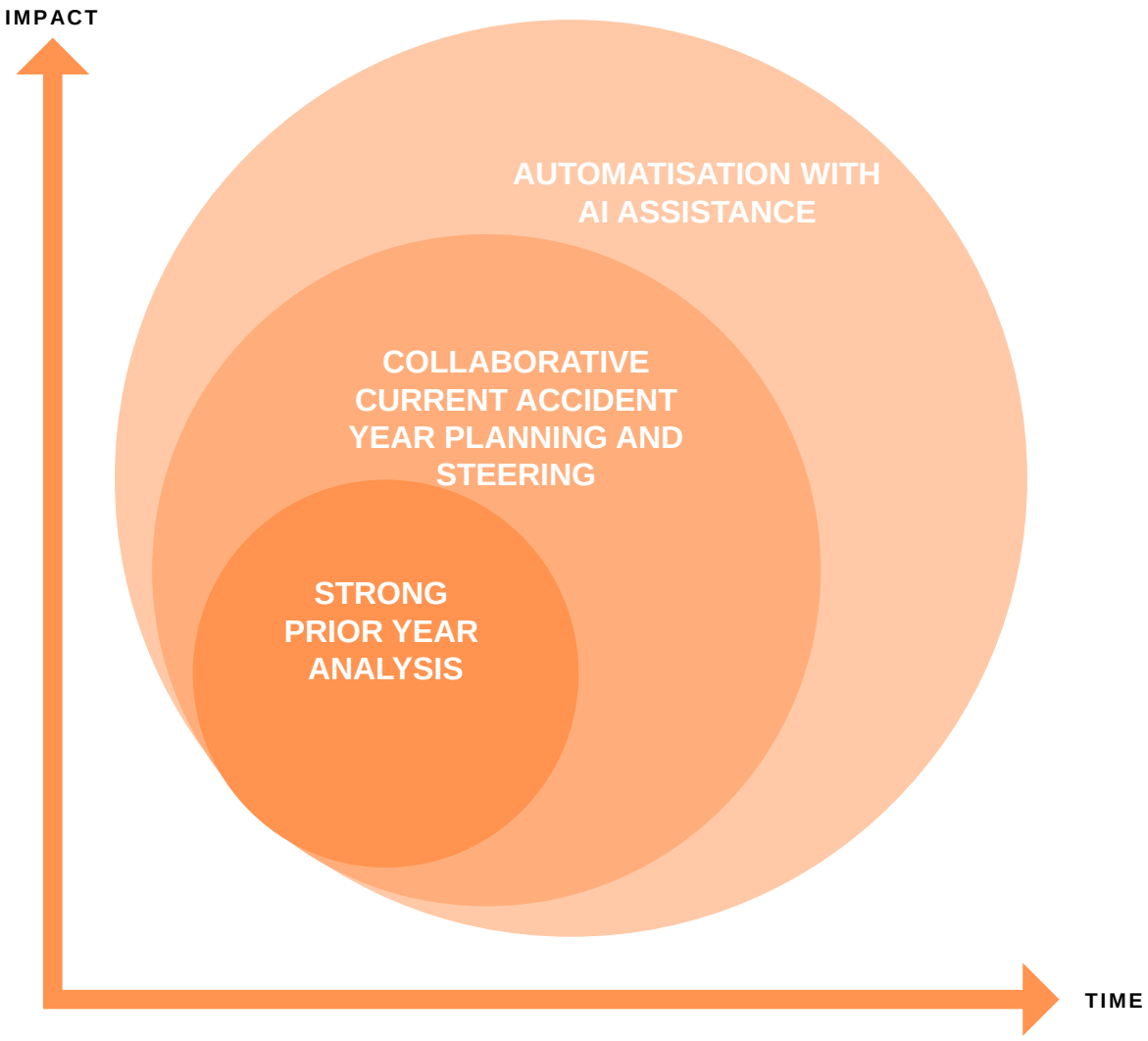
INTRODUCTION



The main purpose of this presentation is to present a pragmatic approach to implement a **simple but efficient reserving framework** which can also be easily automatised with AI / ML

THE JOURNEY: RESERVING WITH AI ASSISTANCE



Ensure that the basics actuarial concepts and KPIs are **well understood and defined univocally** (ie. one source of truth)

The next level leads to the day to day usage of the reserving insights, to **operationalize strategic and planning decisions**

Finally, bring AI into the reserving world, to allow actuaries to **relief resources on reporting efforts** and assist them **to improve their reserving insights even further**

Content Topics

RUNOFF – KEY PRINCIPLES

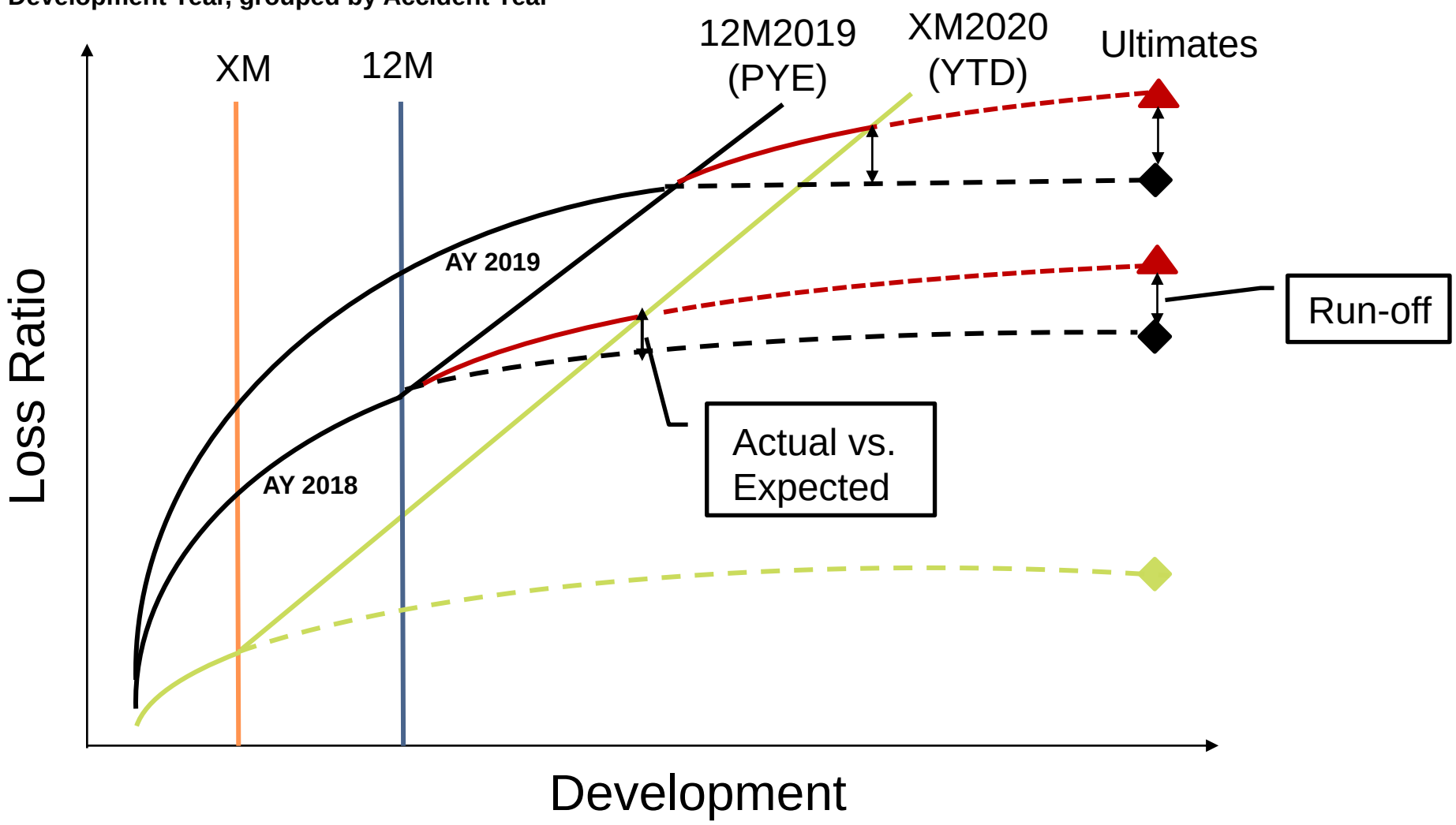
The **actuarial function (AF)** is the **owner** of the **reserves**

THE AF HOLDER SHOULD …

- … be responsible for the **runoff** (gross and net) booked in the P&L
- … **be able to explain** how much of the runoff is driven by *update in data* and how much by *change in assumptions*
- … have an understanding of the **uncertainty of the results**, where:
  - **LOW** is the minimum he/she would sign
  - **MID** is the recommendation
  - **HIGH** is the maximum he/she would sign

RUNOFF – CHANGE IN DATA vs ASSUMPTIONS

Loss ratio by Development Year, grouped by Accident Year



EXAMPLE

RUNOFF - MONITORING

AY	Loss Ratios (Raw data)															Loss Ratios (Booked)				
	Paid				Diagnostic (YTD - PYE)			Incurred				Diagnostic (YTD - PYE)				IFRS				
	06M (1)	12M (2)	PYE (3)	YTD (4)	Actual (5)=(4)-(3)	Expected (6)	A vs E (7)=(5)-(6)	06M (8)	12M (9)	PYE (10)	YTD (11)	Actual (12)=(11)-(10)	Expected (13)	A vs E (14)=(12)-(13)		PYE (15)	YTD (16)	Runoff (17)=(16)-(15)	IFRS vs 12M Incurred (18)=(16)-(9)	Consistency Check (17)>=MIN[(7),(14)]
...																				
2015	25.7%	47.0%	39.0%	39.5%	0.5%-p	0.2%-p	0.3%-p	52.0%	56.5%	62.2%	63.2%	1.0%-p	0.5%-p	0.5%-p		71.0%	71.6%	0.6%-p	15.1%-p	✓
2016	25.7%	50.6%	63.9%	64.0%	0.1%-p	0.2%-p	-0.1%-p	52.0%	61.0%	65.9%	66.0%	0.1%-p	0.1%-p	0.0%-p		67.3%	67.3%	0.0%-p	6.3%-p	✓
2017	25.4%	50.5%	63.6%	63.8%	0.2%-p	0.3%-p	-0.1%-p	52.0%	63.0%	65.7%	65.7%	0.0%-p	0.2%-p	-0.2%-p		67.5%	67.2%	-0.3%-p	4.2%-p	!
2018	24.9%	52.6%	63.6%	63.9%	0.3%-p	0.5%-p	-0.2%-p	47.8%	63.5%	66.1%	66.2%	0.1%-p	0.2%-p	-0.1%-p		68.5%	68.5%	0.0%-p	5.0%-p	✓
2019	25.3%	47.0%	46.9%	54.9%	8.0%-p	8.1%-p	-0.1%-p	72.7%	62.2%	62.2%	64.5%	2.3%-p	2.5%-p	-0.2%-p		68.4%	68.2%	-0.2%-p	6.0%-p	!
2020	27.5%							56.7%									70.6%			
						Total	-0.4%						Total	0.2%			Total	0.1%		✓
						(value)	-4,500,000						(value)	2,000,000			MID	1,000,000		
																	LOW	-4,000,000		
																	HIGH	6,000,000		

- \+ AvE can approximate **update in data**. Difference between *runoff and AvE* approximates **change in assumptions**
- \+ Quick (pragmatic) **back testing for uncertainty**. For example, if PYE booking was:
  - LOW (1in2 years negative runoff return period) ~ a red AvE every 2 years
  - MID (1in3 years negative runoff return period) ~ a red AvE every 3 years
  - HIGH (1in5 years negative runoff return period) ~ a red AvE every 5 years
- \+ Possibility to dig into details as much as needed

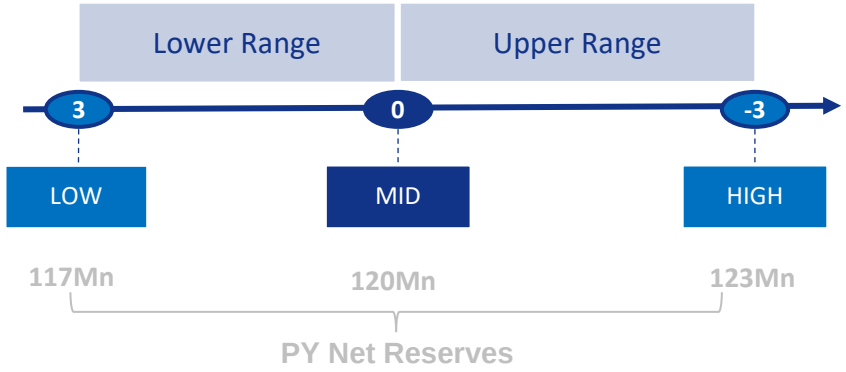
Legend:
Positive values are loss, **negative** are profit

XM: X months development
12M: 12 months development
YTD: year-to-date development
PYE: previous year end development

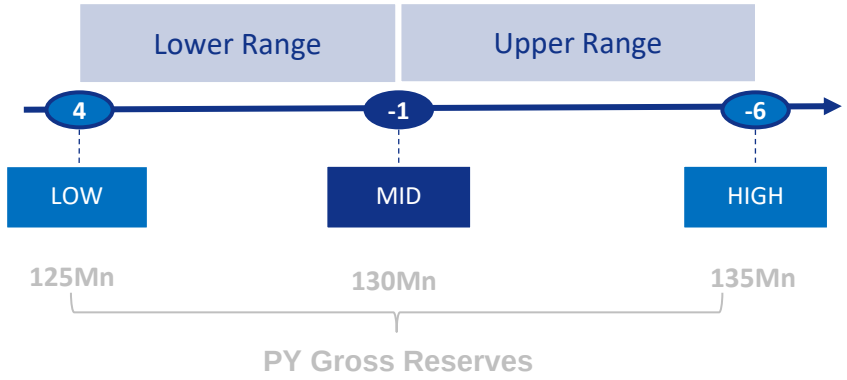
EXAMPLE

RUNOFF - RANGE

Range of Total Net PY Run-off as at 6M2019



Range of Total Gross PY Run-off as at 6M2019



Net Run-Off figures with ULAE in EUR mn, by LoB

LoB	LOW	MID	HIGH
LoB1	5	-0.2	-1
LoB2	1	-1	-3
LoB3	-3	1.2	1
…			
Total	**3**	**0**	**-3**

Gross Run-Off figures with ULAE in EUR mn, by LoB

LoB	LOW	MID	HIGH
LoB1	1	0	-1
LoB2	0.5	-0.5	-2
LoB3	2.5	-0.5	-3
…			
Total	**4**	**-1**	**-6**

Content
Topics

CAY LOSS RATIO – KEY PRINCIPLES

The **actuarial function (AF)** is the **owner** of the **ultimate loss ratio**

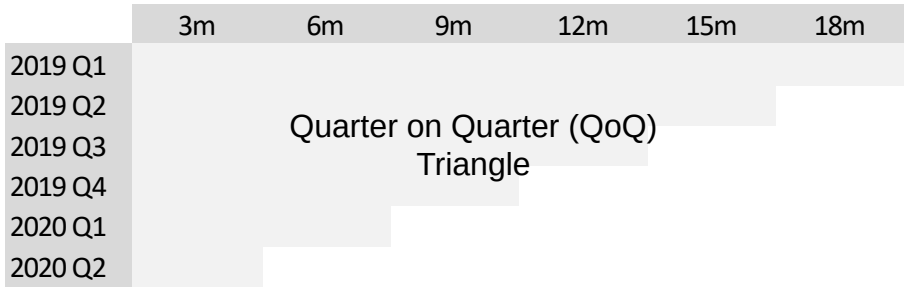
THE AF HOLDER SHOULD …

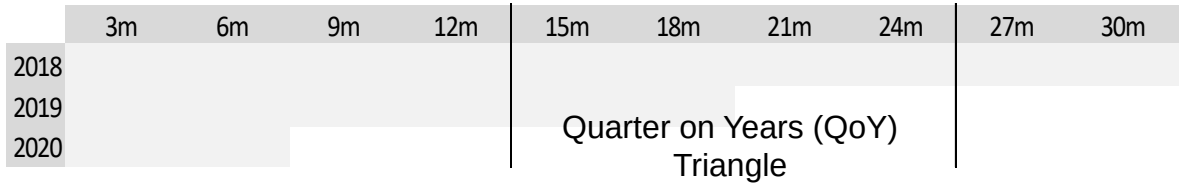
- … be responsible for the **loss ratio** (gross and net) booked in the P&L
- … **be able to explain** how much of the deviation vs Plan is due to the *business areas* (over/under achieving their targets) and *actuarial* (changing their assumptions)
- … have an understanding of the **uncertainty of the results**, where:
  - **LOW** is the minimum he/she would sign
  - **MID** is the recommendation
  - **HIGH** is the maximum he/she would sign

CAY LOSS RATIO – MAIN ISSUES

- There is a **lack of actuarial literature** (can we say there is basically nothing at all?) on the current accident year for quarterly closings
- **Different approaches and definitions** across the market: “year-to-date” or a “full-year” ultimate loss ratio?
- Roles&Responsibilities (between actuarial/pricing/claims/underwriting/etc) usually **not clearly defined**

CAY LOSS RATIO – TWO COMMON MARKET APPROACHES





"Year-to-date" approach

We assume the company in "runoff", ie. what is the ultimate loss ratio if the unearned exposure won't happen

- − Premium reserves (S2 / IFRS17) should reflect the profitability of the unearned part
- − Doesn't naturally reflect annual business exposure (eg. pricing, BF, etc.)
- − Erratic projections (as relies on quarterly data)

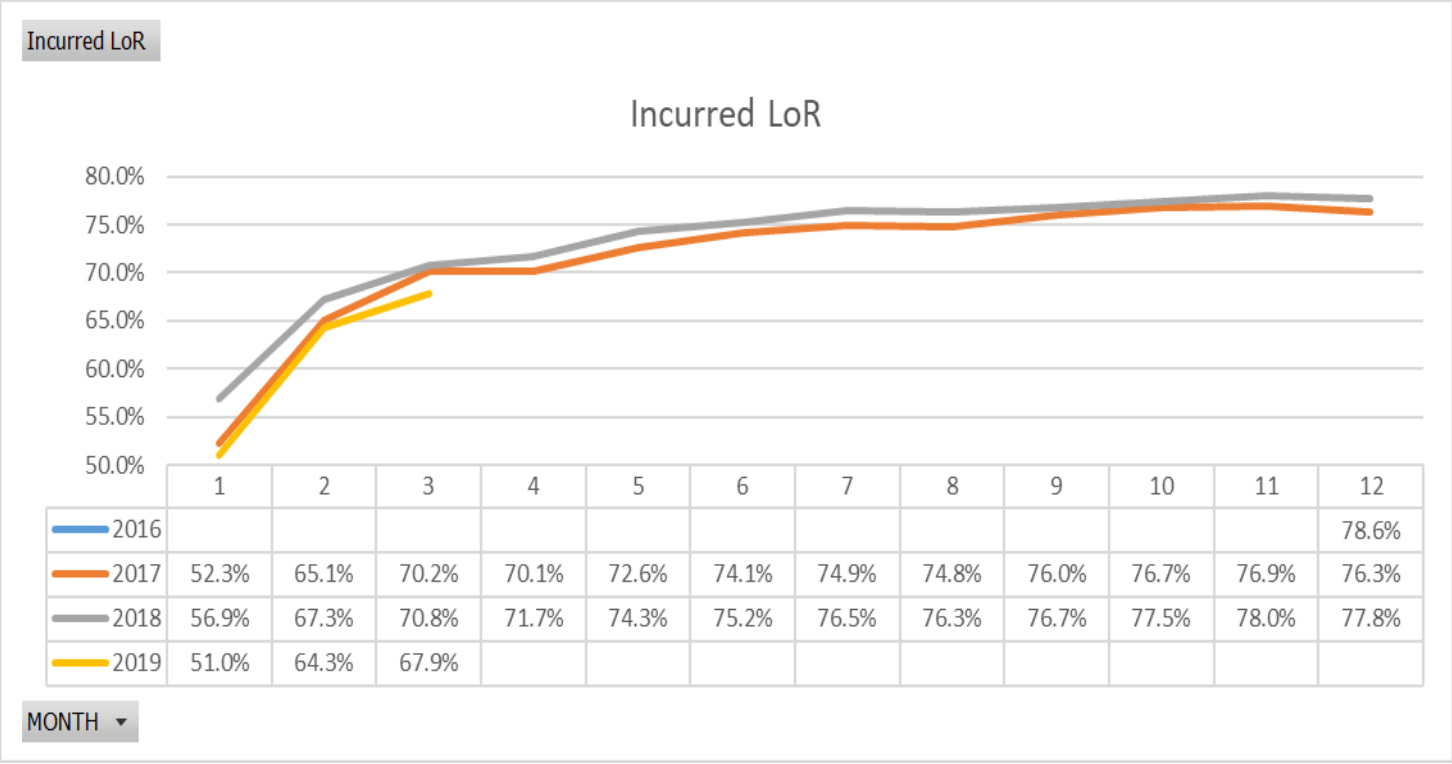
"Full year" approach

We consider also the future claims/exposure that will happen in the year

- + Premium reserves (S2 / IFRS17) can use the same loss ratio of the CAY
- + Easy to interpret, as gives a feeling of (yearly) normalised loss ratio (eg. pricing, BF, etc.)
- + Stable projections with possibility to spot change in trends (quarter or month development)
- + Immediate reconciliation with Technical KPIs

“FULL YEAR” APPROACH – (NO) SEASONALITY

Another advantage is that in a “full year” approach, the **Ultimate** Loss Ratio (ULR) **does not have** a seasonality, whilst the **Incurred** Loss Ratio (ILR) does



	1	2	3	4	5	6	7	8	9	10	11	12
2016												78.6%
2017	52.3%	65.1%	70.2%	70.1%	72.6%	74.1%	74.9%	74.8%	76.0%	76.7%	76.9%	76.3%
2018	56.9%	67.3%	70.8%	71.7%	74.3%	75.2%	76.5%	76.3%	76.7%	77.5%	78.0%	77.8%
2019	51.0%	64.3%	67.9%									

Example from chart:

(1) If in March we observe a **67.9% incurred**, and we know that the business is fully developed after 12months (ie. No IBNER/IBNYR), how much IBNR would you book? *Answer: ~10%-p*

(2) And if in June we still observe something in line with the past, ie. ~75%, how much IBNR should we book? *Answer: ~3%-p*

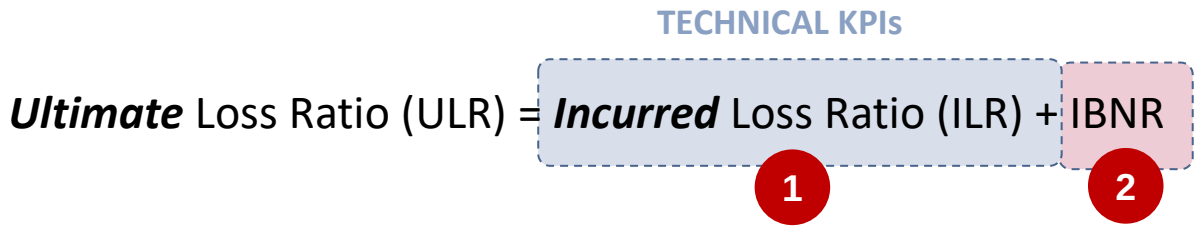
(3) And towards the end of the year you will have an **IBNR more accurate** thanks to the emerging experience (*) …

In other words, the ULR in the example is always **around 78%** (“normalized” loss ratio), and the volatility around it depends on the **emerging** loss experience: it is **random**, not **seasonal**.

(*) NOTE: the above is true also if the incurred is higher than the ultimate – of course, in this case, booking a negative IBNR the analyst should pay even more attention …

ULTIMATE LOSS RATIO – INCURRED AND IBNR

For this reason, we need to ensure that observed data (**Technical KPIs**) are reported separately from actuarial adjustments (**IBNR and large/natcat(*)**), to ensure a clear ***performance tracking***:



Incurred Loss Ratio (ILR): Represent the total cost of the claim w/o IBNR

☑ Basis for discussion with the **business areas** (claims/pricing/underwriting..) on a recurrent basis.

Technical KPIs must reconcile to the incurred loss ratio

IBNR: it is the sum of IBNER (Incurred But Not Enough Reserved) + IBNYR (Incurred But Not Yet Reported)

☑ Main discussion with the **actuarial function**, to be validated against prior year analysis

(*) Note: large/natcat losses are modeled via EVT (eg. Pareto/Poisson model or exposure based) and excluded from this presentation

CAY – LR COMPONENTS

	Loss Ratios (Raw data)														Loss Ratios (Booked)				
	Paid				Diagnostic (YTD - PYE)			Incurred				Diagnostic (YTD - PYE)			IFRS				
AY	06M (1)	12M (2)	PYE (3)	YTD (4)	Actual (5)=(4)-(3)	Expected (6)	A vs E (7)=(5)-(6)	06M (8)	12M (9)	PYE (10)	YTD (11)	Actual (12)=(11)-(10)	Expected (13)	A vs E (14)=(12)-(13)	PYE (15)	YTD (16)	Runoff (17)=(16)-(15)	IFRS vs 12M Incurred (18)=(16)-(9)	Consistency Check (17)>=MIN[(7),(14)]
...																			
2015	25.7%	47.0%	39.0%	39.5%	0.5%-p	0.2%-p	0.3%-p	52.0%	56.5%	62.2%	63.2%	1.0%-p	0.5%-p	0.5%-p	71.0%	71.6%	0.6%-p	15.1%-p	
2016	25.7%	50.6%	63.9%	64.0%	0.1%-p	0.2%-p	-0.1%-p	52.0%	61.0%	65.9%	66.0%	0.1%-p	0.1%-p	0.0%-p	67.3%	67.3%	0.0%-p	6.3%-p	
2017	25.4%	50.5%	63.6%	63.8%	0.2%-p	0.3%-p	-0.1%-p	52.0%	63.0%	65.7%	65.7%	0.0%-p	0.2%-p	-0.2%-p	67.5%	67.2%	-0.3%-p	4.2%-p	
2018	24.9%	52.6%	63.6%	63.9%	0.3%-p	0.5%-p	-0.2%-p	47.8%	63.5%	66.1%	66.2%	0.1%-p	0.2%-p	-0.1%-p	68.5%	68.5%	0.0%-p	5.0%-p	
2019	25.3%	47.0%	46.9%	54.9%	8.0%-p	8.1%-p	-0.1%-p	72.7%	62.2%	62.2%	64.5%	2.3%-p	2.5%-p	-0.2%-p	68.4%	68.2%	-0.2%-p	6.0%-p	
2020	27.5%							56.7%								70.6%			
						Total	-0.4%						Total	0.2%		Total	0.1%		
						(value)	-4,500,000						(value)	2,000,000		MID	1,000,000		
																LOW	-4,000,000		
																HIGH	6,000,000		

1

2

***First* we need to project from XM to 12M (ie. 12M Incurred Rolling Projection):**

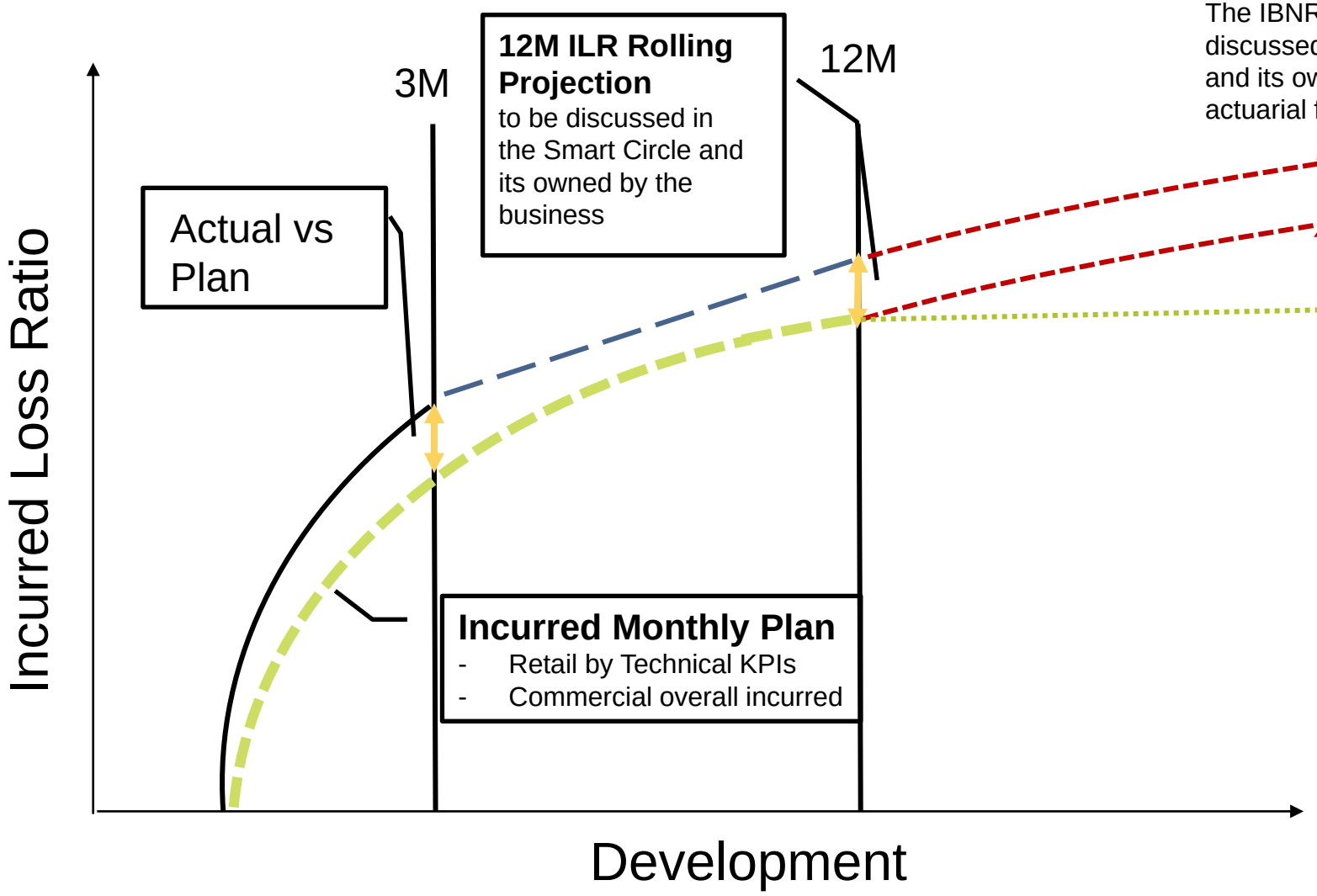
- This is done comparing the XM with the **incurred plan** as of XM (**prospective view**)
- Retail LoBs could be done by Technical KPI
- Commercial LoBs by Total Incurred LR

This is the key link between **actuarial and business areas**

***Second* we need to project from 12M to Ultimate**

- This is based on the historical ratios 12M to Ultimate
- They depend on PY, thus linked to AvE
- For this reason it is important to show the historical pattern
- Usually the ratios should not show patterns – if patterns are shown, it means something is changing in the claims area and needs to be discussed!

CAY – ACTUAL vs monthly PLAN



IFRS LR @ 3M

The IBNR is to be discussed in the LoRC and its owned by the actuarial function

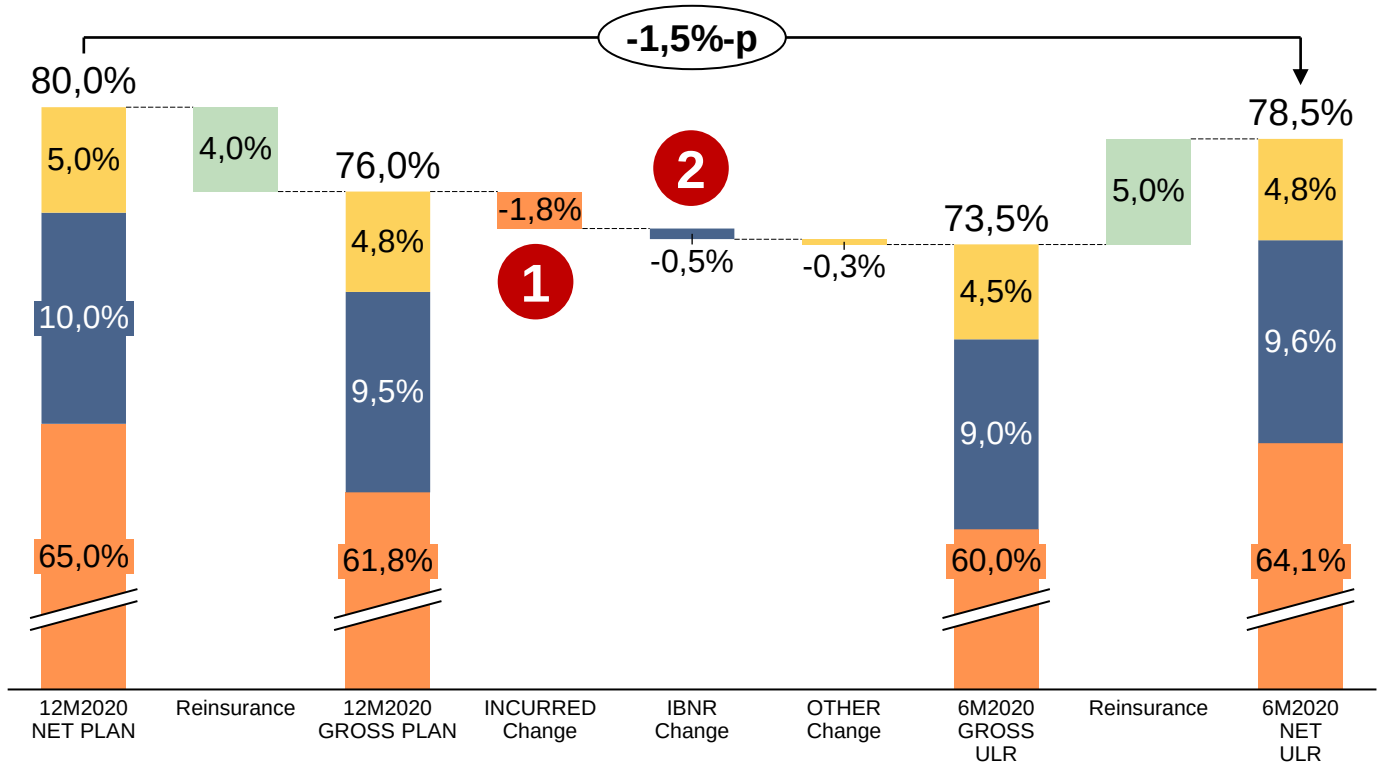
Plan Ultimate Loss Ratio

12M PLAN IBNR

- The **accounting IBNR** depends on the point in time we are, and it is always defined by Ultimate - Incurred
- To make the IBNR comparable in time, we analyse the **IBNR always at 12M**. For this reason we need (1) a Rolling Projection to 12M and then (2) a 12M Incurred to Ultimate factor

EXAMPLE

OE – CAY WALK



+ Company year-end target always under control
+ Clear understanding of the movements, business vs actuarial to enable quick reactions
+ Possibility to dig into details as much as needed

Business areas

Key comments to explain the differences with the business

1

Actuarial

Key comments on IBNR change

2

Other

Any other comments (large losses/ULAE/etc)

EXAMPLE

1 OE – ACTUAL VS PLAN

+ Comparison vs the plan (incurred only), vs past for reference
+ Automatic RP as of year-end (credibility approach)

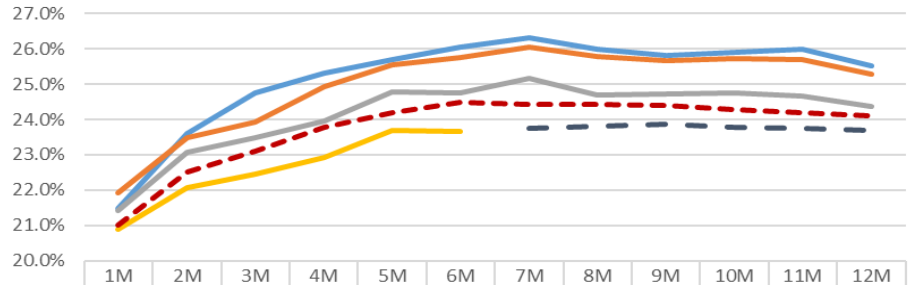
LoB			ACTUAL			(INCURRED) PLAN					
	Monitoring (ATTR/TOTAL)	GEP/NEP 05M2020	ILR 05M2019	ILR 05M2020	Actual vs PY ILR	Plan ILR 05M2020	Actual vs 05M Plan	Incurred RP 12M2020	Plan ILR 12M2020	12M Incurred RP vs 12M Plan	Consistency Check
	(1)	*(2)*	*(3)*	*(4)*	*(5)=(4)-(3)*	*(6)*	*(7)=(4)-(6)*	*(8)*	*(9)*	*(10)=(8)-(9)*	*(10)>=(7)*
LoB1	Total	1,200	45.0%	47.0%	2.0%-p	48.0%	-1.0%-p	49.5%	50.0%	-0.5%-p	✓
LoB2					0.0%-p		0.0%-p			0.0%-p	✓
MOTOR					0.0%-p		0.0%-p		focus	0.0%-p	✓
LoB3					0.0%-p		0.0%-p			0.0%-p	✓
LoB4					0.0%-p		0.0%-p			0.0%-p	✓
PL					0.0%-p		0.0%-p		focus	0.0%-p	✓
LoB5					0.0%-p		0.0%-p			0.0%-p	✓
LoB6					0.0%-p		0.0%-p			0.0%-p	✓
…					0.0%-p		0.0%-p			0.0%-p	✓
CL					0.0%-p		0.0%-p			0.0%-p	✓
Total					0.0%-p		0.0%-p			-1.8%-p	✓

Reconciled with the walk

EXAMPLE

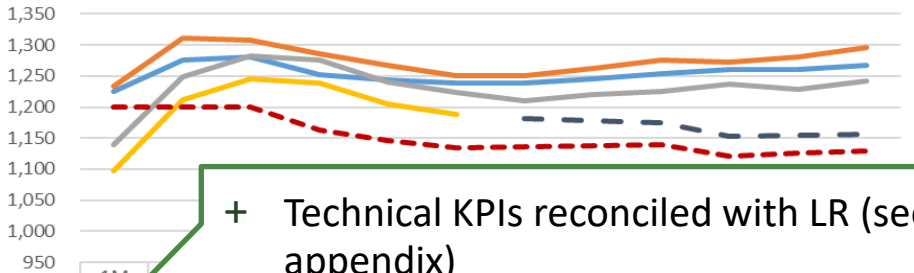
1 FOCUS LOB 1 – TECHNICAL KPIS

Frequency



	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M
2017- Actual	21.5%	23.6%	24.8%	25.3%	25.7%	26.0%	26.3%	26.0%	25.8%	25.9%	26.0%	25.5%
2018- Actual	21.9%	23.5%	23.9%	24.9%	25.6%	25.8%	26.1%	25.8%	25.7%	25.7%	25.7%	25.3%
2019- Actual	21.4%	23.1%	23.5%	24.0%	24.8%	24.8%	25.2%	24.7%	24.7%	24.8%	24.6%	24.4%
2020- Actual	20.9%	22.1%	22.5%	22.9%	23.7%	23.7%						
2020 - Plan	21.0%	22.5%	23.1%	23.8%	24.2%	24.5%	24.4%	24.4%	24.4%	24.3%	24.2%	24.1%
2020 - Roll Prj							23.7%	23.8%	23.9%	23.8%	23.7%	23.7%

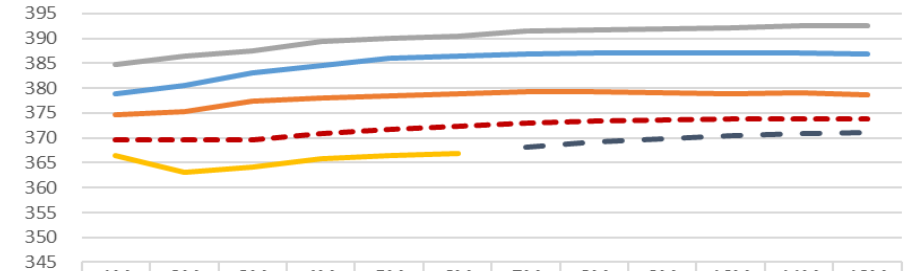
Severity



	1M	
2017- Actual	1,226	
2018- Actual	1,234	1,31
2019- Actual	1,139	1,24
2020- Actual	1,097	1,21
2020 - Plan	1,200	1,20
2020 - Roll Prj		

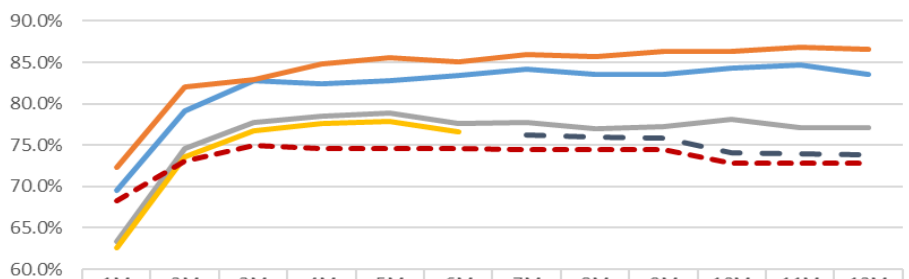
+ Technical KPIs reconciled with LR (see appendix)
+ Possibility to dig down at detailed level
+ Quick overview of actuals, plan and rolling projection

Avg Premium



	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M
2017- Actual	379	381	383	385	386	386	387	387	387	387	387	387
2018- Actual	375	375	377	378	379	379	379	379	379	379	379	379
2019- Actual	385	386	388	389	390	390	392	392	392	392	393	393
2020- Actual	366	363	364	366	366	367						
2020 - Plan	370	370	370	371	372	372	373	373	374	374	374	374
2020 - Roll Prj							368	369	370	370	371	371

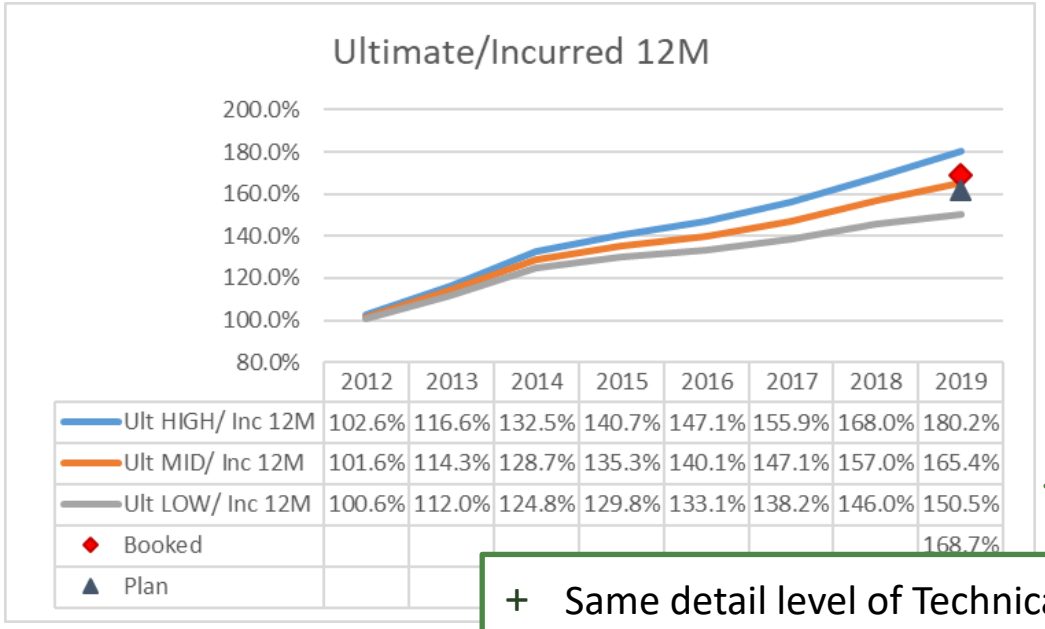
Incurred LR



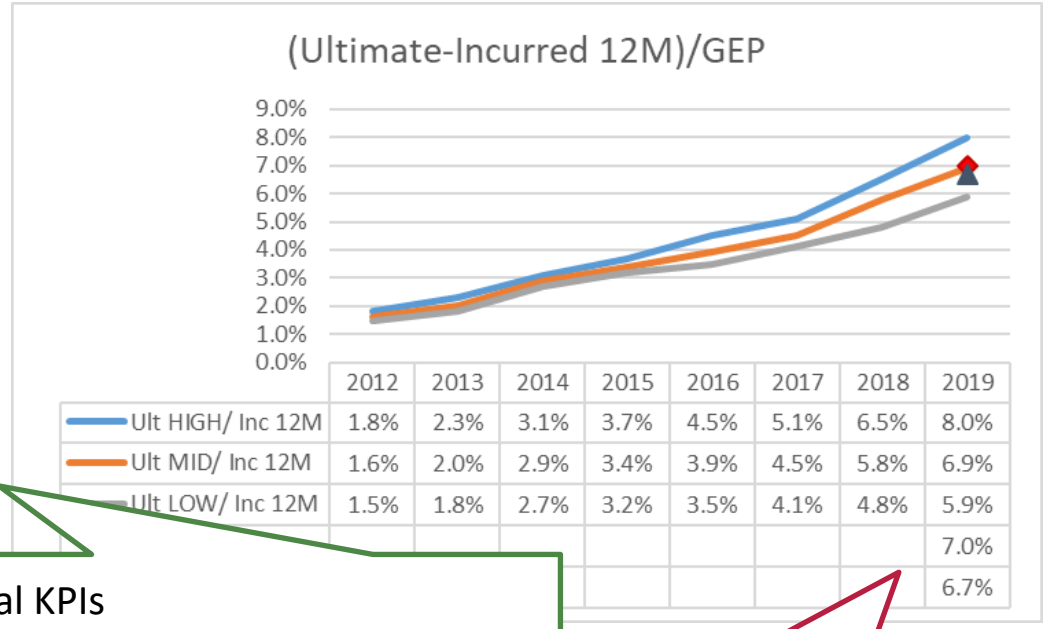
	1M	2M	3M	4M	5M	6M	7M	8M	9M	10M	11M	12M
2017- Actual	69.5%	79.1%	82.8%	82.4%	82.8%	83.5%	84.2%	83.6%	83.6%	84.4%	84.7%	83.5%
2018- Actual	72.2%	82.0%	82.9%	84.8%	85.6%	85.0%	85.9%	85.7%	86.3%	86.3%	86.8%	86.6%
2019- Actual	63.4%	74.5%	77.8%	78.5%	78.9%	77.6%	77.8%	77.0%	77.3%	78.1%	77.2%	77.1%
2020- Actual	62.6%	73.6%	76.8%	77.6%	77.9%	76.6%						
2020 - Plan	68.2%	73.1%	75.0%	74.6%	74.6%	74.6%	74.4%	74.4%	74.4%	72.8%	72.8%	72.8%
2020 - Roll Prj							76.2%	76.0%	75.8%	74.0%	73.9%	73.8%

EXAMPLE

2 OE – 12M INCURRED TO ULTIMATE RATIO



	2012	2013	2014	2015	2016	2017	2018	2019
Ult HIGH/ Inc 12M	102.6%	116.6%	132.5%	140.7%	147.1%	155.9%	168.0%	180.2%
Ult MID/ Inc 12M	101.6%	114.3%	128.7%	135.3%	140.1%	147.1%	157.0%	165.4%
Ult LOW/ Inc 12M	100.6%	112.0%	124.8%	129.8%	133.1%	138.2%	146.0%	150.5%
Booked								168.7%
Plan								



	2012	2013	2014	2015	2016	2017	2018	2019
Ult HIGH/ Inc 12M	1.8%	2.3%	3.1%	3.7%	4.5%	5.1%	6.5%	8.0%
Ult MID/ Inc 12M	1.6%	2.0%	2.9%	3.4%	3.9%	4.5%	5.8%	6.9%
Ult LOW/ Inc 12M	1.5%	1.8%	2.7%	3.2%	3.5%	4.1%	4.8%	5.9%
								7.0%
								6.7%

Reconciled with the walk

Comments

+ Same detail level of Technical KPIs
+ They represent the ratio between ultimate and case reserves as year-end from PY analysis:
  + **Flat trend** – no significant changes in case reserve policy
  + **Increasing trend** – case reserves tend to have “less money” over time to pay for claims
  + **Decreasing trend** – case reserves tend to have “more money” over time to pay for claims
+ Comparison of booking vs Plan and PY ranges

Content
Topics

BRIDGING ACTUARIAL AND DATA SCIENCE WORLD

TRADITIONAL ACTUARIAL APPROACH

Basic methodologies based on **triangles**

Data	Aggregated data
Data Aggregation	"Human Aggregation"
Projection	Actuarial Methodologies
	Assume to work on **grouped data**

TRAJECTORY-BASED APPROACH (*)

Regression models based on claims evolution over time

Data	Claims historical patterns
Data Aggregation	Clustering
Projection	(Constrained) Regression
	No "**claim features**"

DATA SCIENCE APPROACH

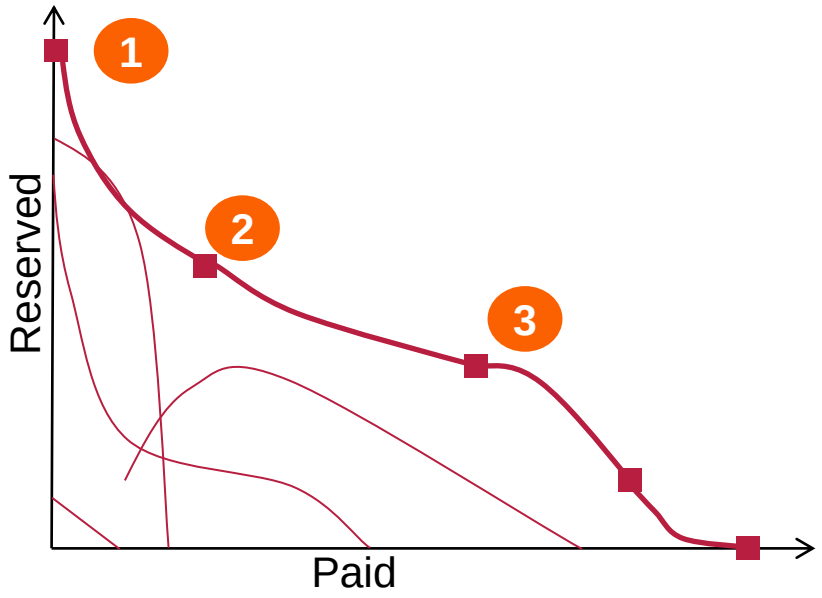
Individual claims reserving with **ML Algorithms** (i.e. Gradient Boosting, NN etc.)

Data	Claim-by-claim dataset
Data Aggregation	Not required
Projection	Individual via ML Algorithms
	"**Claim features**" required

(*) Carrato, Visintin (2019) - „From Chain Ladder to Individual Claims Reserving with Machine Learning" (ASTIN Colloquim 2019)

Video: https://www.actuview.com/from-the-chain-ladder-to-individual-claims-reserving-using-machine-learning-techniques_4a3da9262.html

THE PAID-RESERVED TRAJECTORY



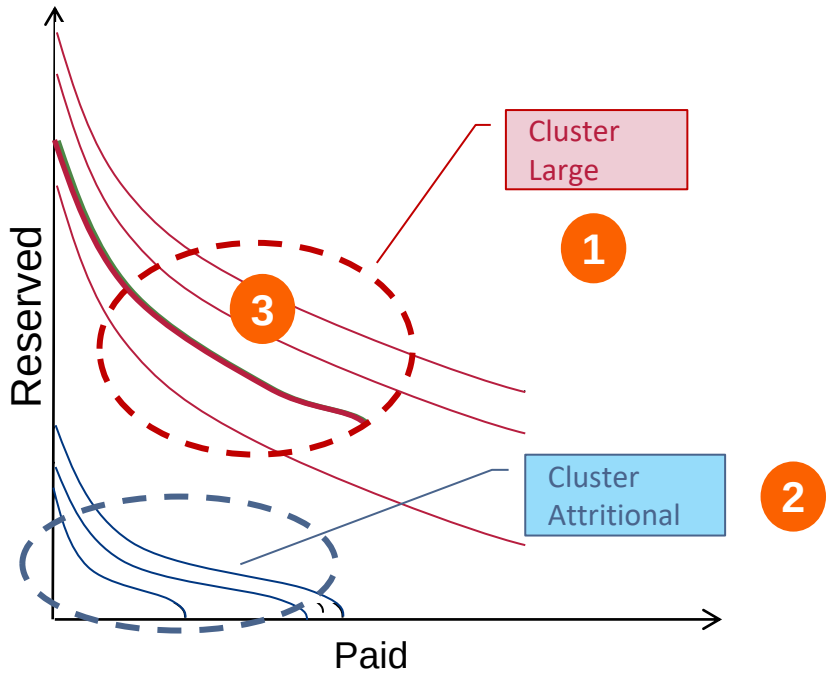
1. After its occurence, a claim is reported and a case reserve is allocated

2. Subsequently, a certain amount is paid and the case reserve decreases accordingly

3. The claim continues its developing until is definitively closed (Ultimate Cost)

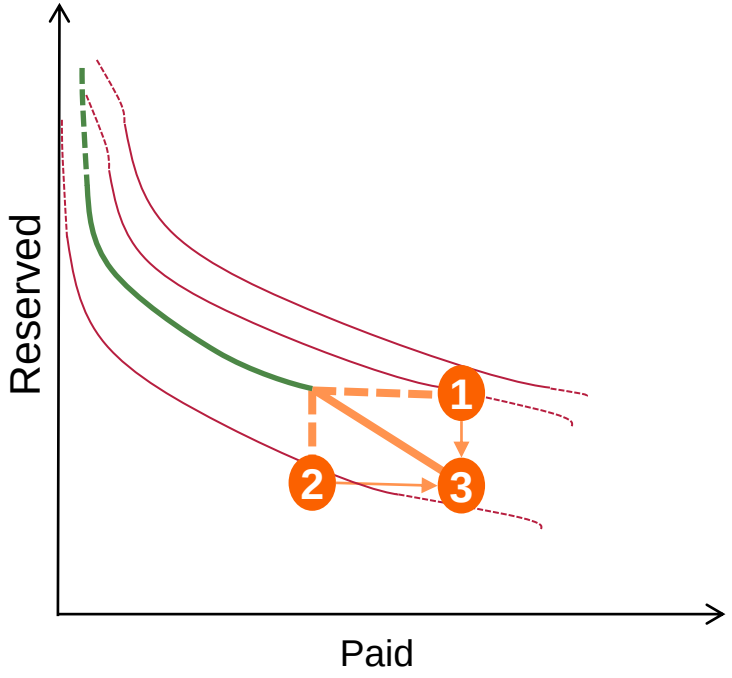
THE TWO-STEPS ALGORITHM

Step 1 – Clustering



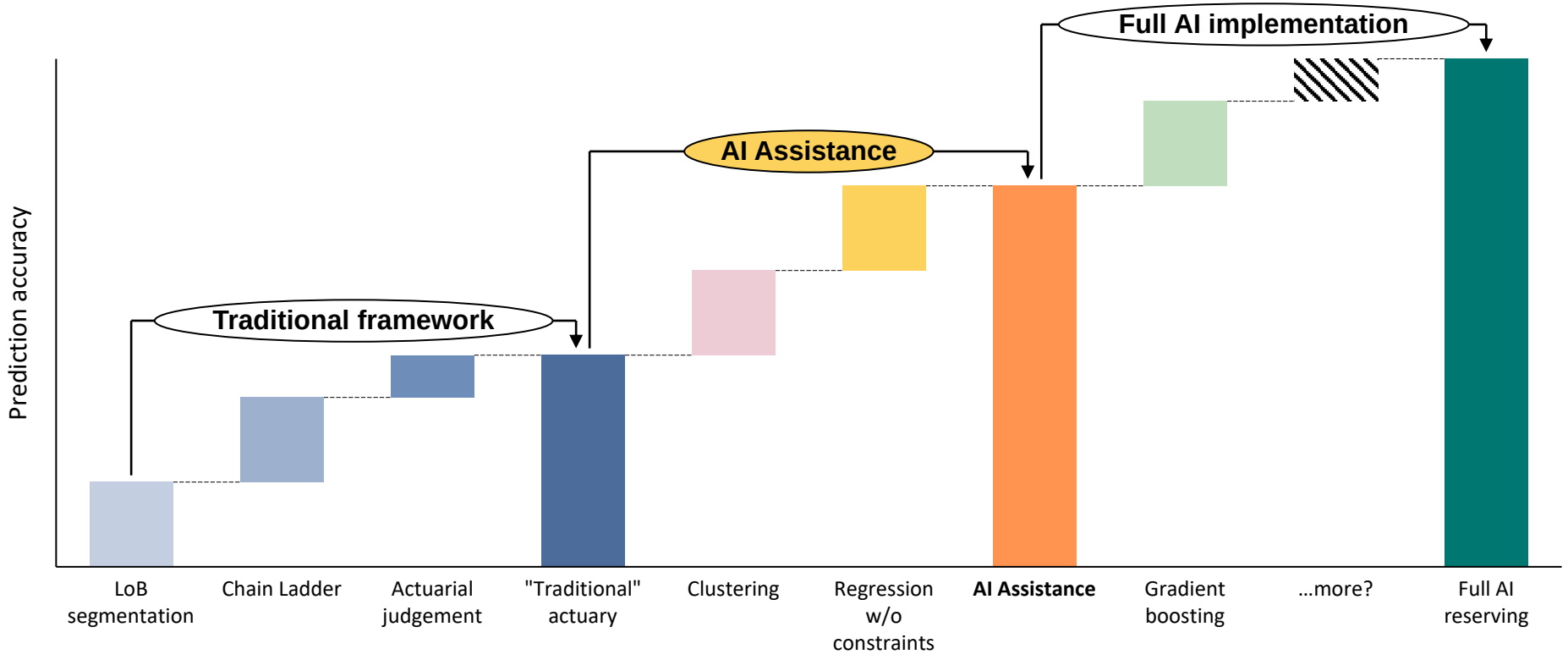
With clustering techniques, **we are able to identify and aggregate claims with similar trajectories** up to a fixed development period

Step 2 – Projection



Two **linear regression** model, are fit on **historical** claims data to develop the **paid amount** (1) and the **reserved amounts** (2).
Therefore, the projected point has coordinates defined by (1) and (2)

THE LONG ROAD OF AI RESERVING …



Before moving to full AI implementation, we need to ensure that (1) we are able to replicate most of the existing processes with an automatic process and (2) that we have “one single source of truth”

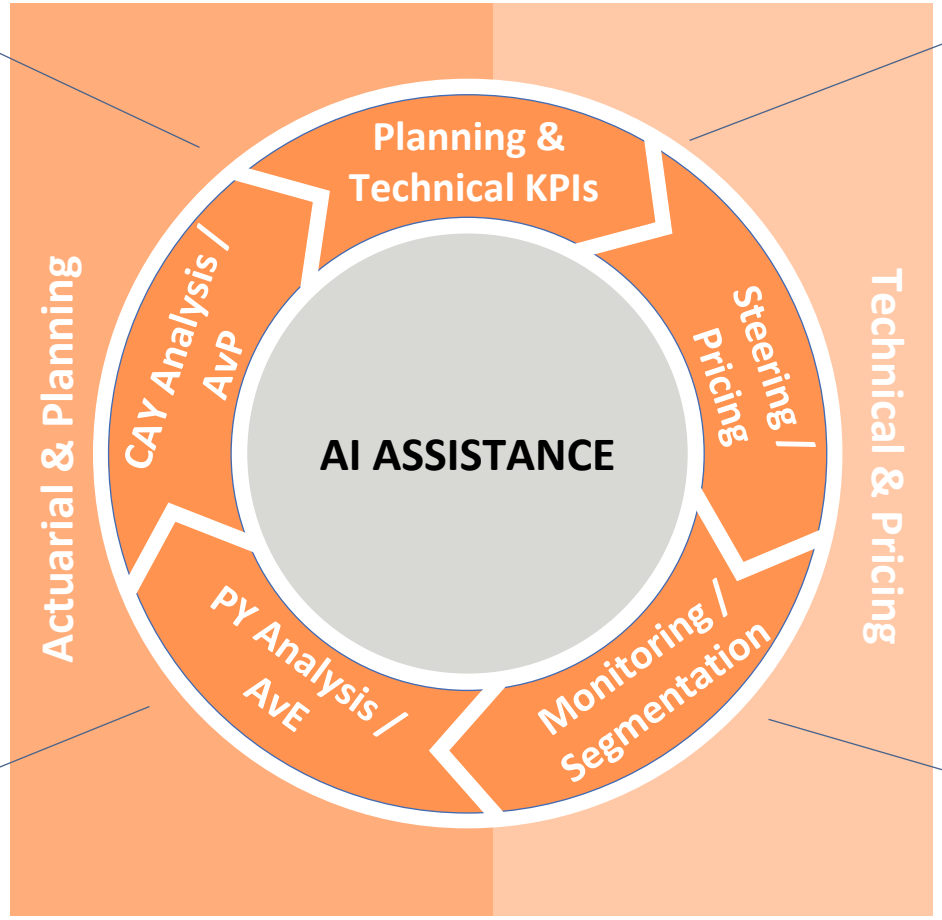
IN CONCLUSION – ONE PLATFORM FOR ALL

Current Year analysis:

- Actual vs Plan for Technical KPIs
- 12M Incurred to Ultimate for IBNR

Prior Year analysis:

Actual vs Expected analysis at any granularity



Planning cycle:

Clearly define business targets vs actuarial assumptions

Monitoring:

All monitoring should come from the same system / one source of truth and run on regular basis

MANY THANKS FOR YOUR ATTENTION

APPENDIX - FORMULAE

TECHNICAL KPIs DEFINITION

$$\textbf{Incurred LR} = \frac{Incurred\ Claims}{Earned\ Premiums} = \frac{\frac{Incurred\ Claims}{\textbf{Reported (non nil) Claims}} * \textbf{Reported (non nil) Claims}}{Earned\ Premiums} = \frac{\frac{Incurred\ Claims}{Reported\ (non\ nil)\ Claims} * \frac{Reported\ (non\ nil)\ Claims}{\textbf{Risk years}}}{\frac{Earned\ Premiums}{\textbf{Risk years}}}$$

$$= \frac{\textbf{severity} * \textbf{frequency}}{\textbf{avg premium}}$$

$$\textbf{Severity} = \frac{Incurred\ Claims}{Reported\ (non\ nil)\ Claims} \qquad \textbf{Frequency} = \frac{Reported\ (non\ nil)\ Claims}{Risk\ years} \qquad \textbf{Avg. Premium} = \frac{Earned\ Premiums}{Risk\ years}$$

ACTUAL VS EXPECTED DEFINITION

$$\textbf{Actual} = Triangle\ Latest_{t+x} - Triangle\ Latest_{t}$$

$$\textbf{Expected} = (Ultimate_{t} - Triangle\ Latest_{t}) * \frac{(Pattern_{t+x} - Pattern_{t})}{(1 - Pattern_{t})}$$

Where:

- *Previous Year End = t*
- *Year To Date = t+x*
- And $Pattern_{t+x}$ and $Pattern_{t}$ stand for the percentage developed YTD (ie. *t+x*) and for the percentage developed as at PYE Date (*t*), respectively.

AUTHOR

Alessandro Carrato has been working at Allianz SE as Regional Chief Actuary for Iberia&LatAm regions since 2019. Before that, he worked in various actuarial, risk management and product development roles across different countries. He is currently a certified actuary for both italian (ISOA) and english (FIA) actuarial associations and holds a MSc in Statistics and Actuarial Science from the University of Trieste. During his career, he has been presenter and speaker at several conferences, focusing mainly on Non Life actuarial topics. Since 2012, he is also a co-author of the R ChainLadder package and recently his main interests are around bridging the actuarial world to the modern data science techniques.

QR contact details:

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