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Managing Model Complexity

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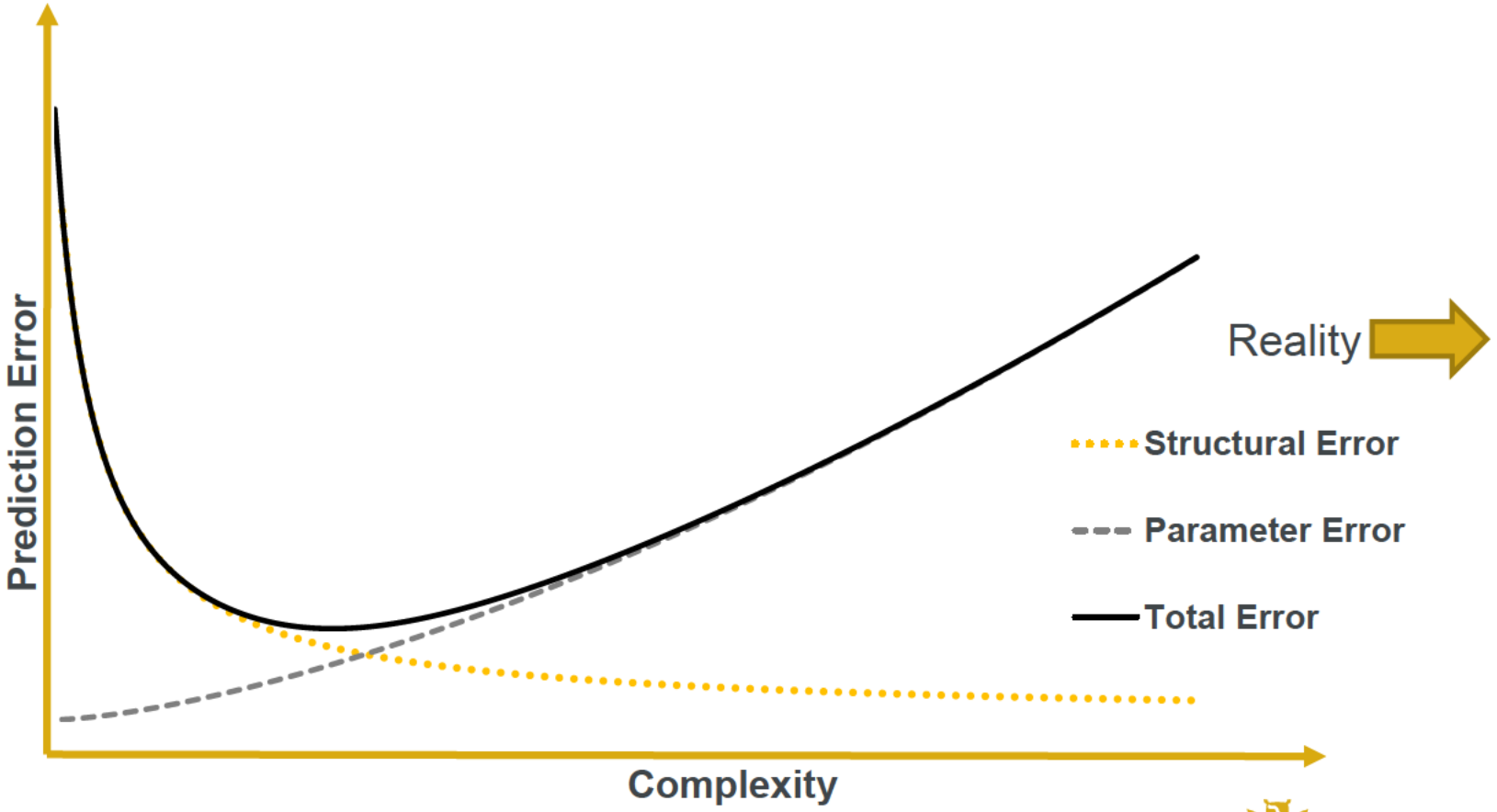
Agenda

- What is the problem with complexity?
- Are GI capital models over-complex?
  - GI Capital Model Survey
- Why does complexity happen?
- Example – Big Correlation Matrices
- Where should we go from here?

Balancing Simplicity and Complexity



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Why do Overly Complex Models Fail?

- Complexity can make models worse - not better - representations of reality
- *"The simplest law is chosen because it is most likely to give correct predictions"*
  - Harold Jeffreys, "Theory of Probability", 1939
- There are also practical problems:
  - Prone to errors
  - Unclear what the key assumptions are
  - Cumbersome to operate
  - Time consuming to parameterise

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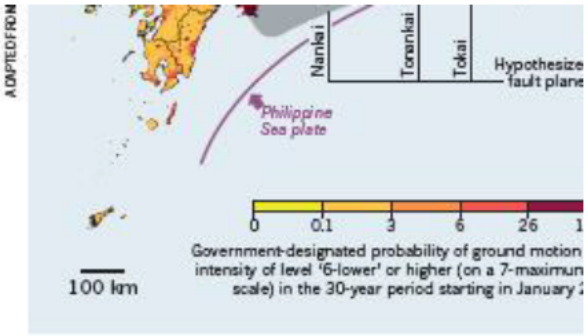
Earthquake Example

Seismic Hazard Map of Japan pre 2011

- Maximum possible earthquake for Tohoku area magnitude~8

Geller, Robert J. "Shake-up time for Japanese seismology." *Nature* 472.7344 (2011): 407-409.



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Earthquake Frequency-Magnitude Models

Two models of expected annual number of earthquakes n greater than seismic moment M:

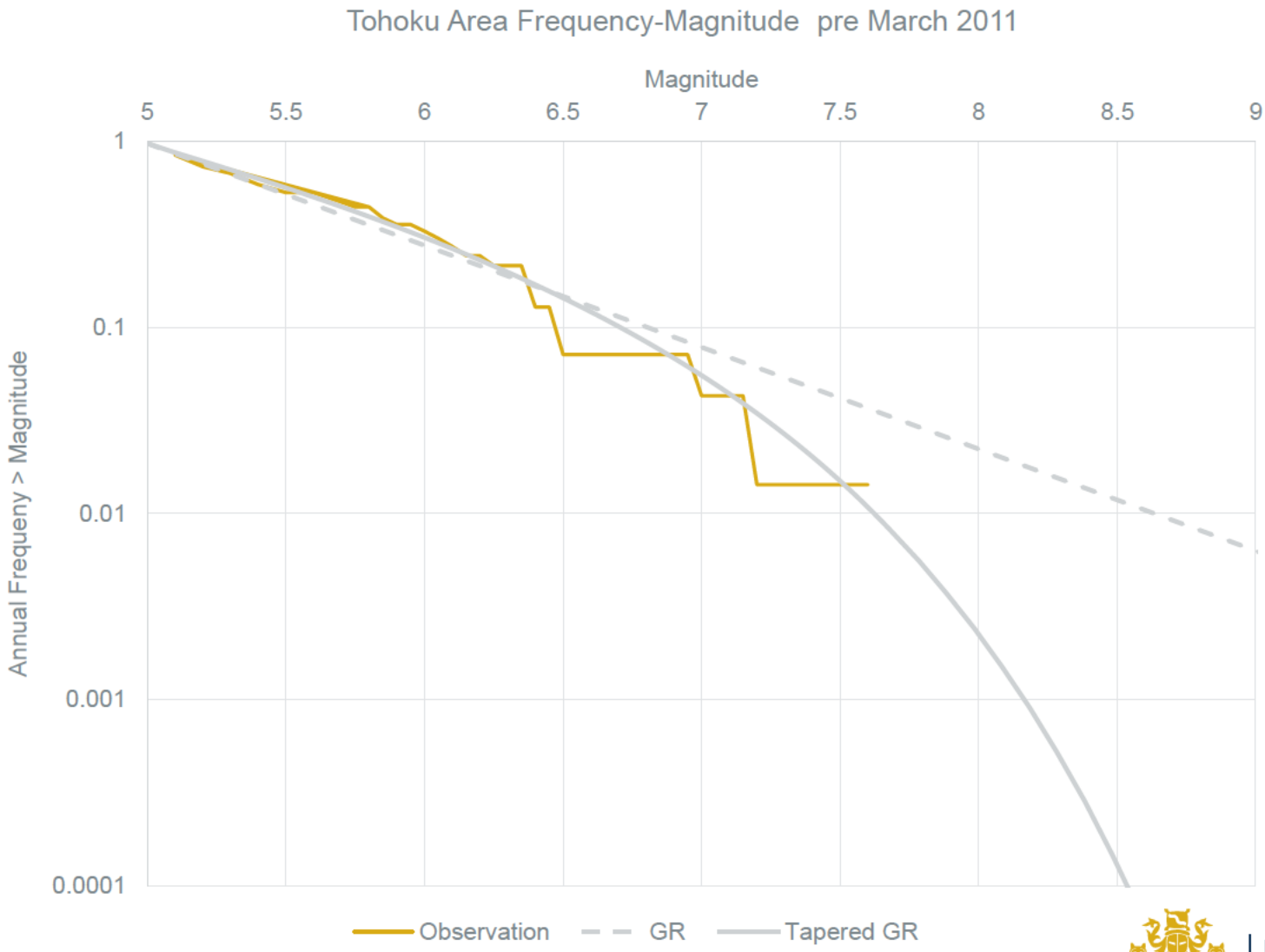
1. Guttenberg-Richter (GR) model

$$n(M) \propto \mathrm{M}^{-\alpha}$$

2. Tapered GR model

$$n(M) \propto \mathrm{M}^{-\alpha} \exp\left(\frac{M}{M_c}\right)$$

NB Moment Magnitude $m_W = \frac{2}{3}(\log_{10} M - 9.0)$



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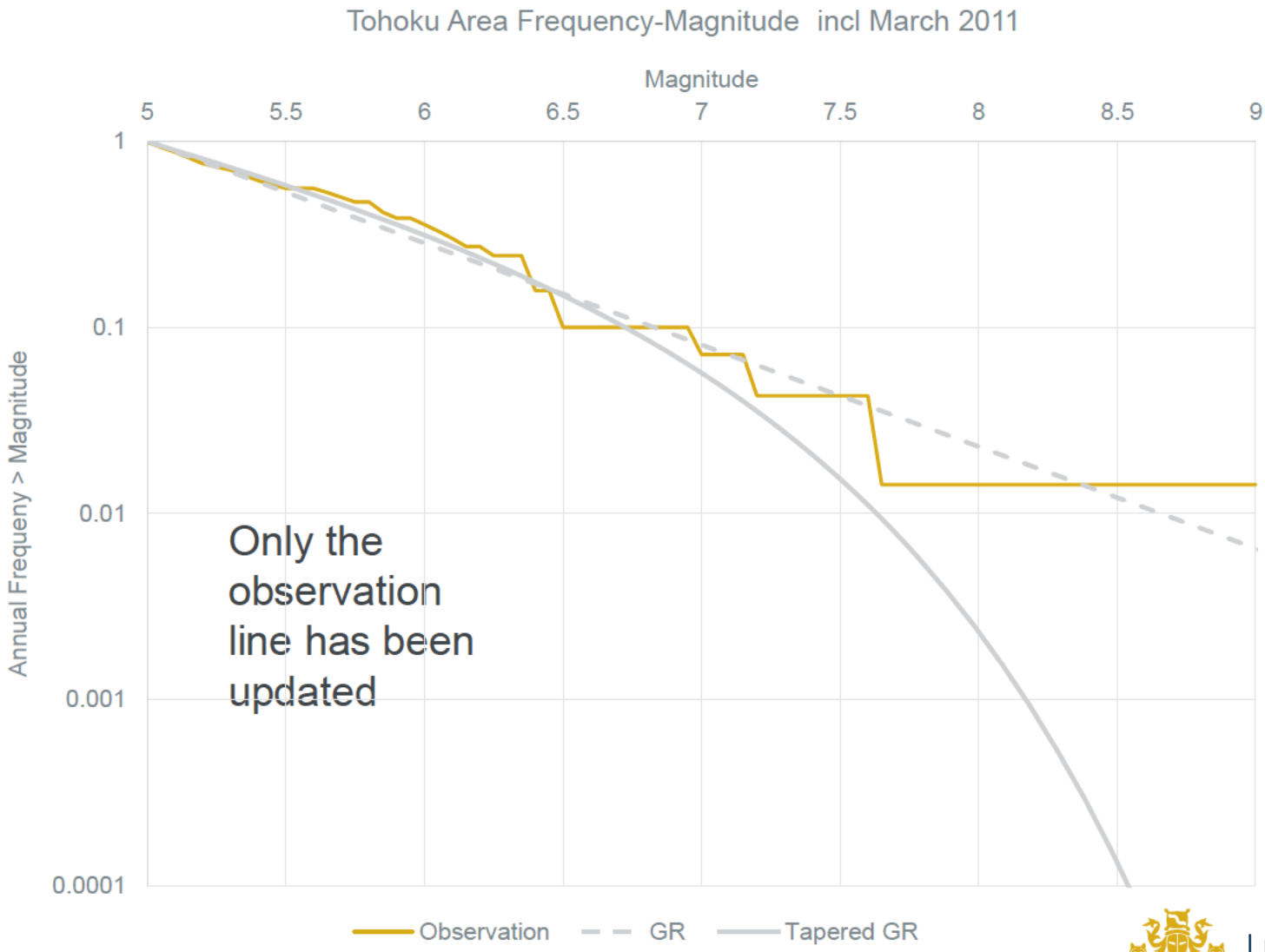

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Avoiding Over-Complexity the Technical Way

- Statisticians have developed a number of methods to avoid over complicating models:
  - Akaike Information Criterion
  - Bayes Schwartz Information Criterion
  - Cross Validation
  - Bayes Factors & Bayesian Model Selection
  - Deviance Information Criterion
  - and others
- Perhaps not possible to apply in all situations
- What do you do if you have no data?

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Complexity in GI Capital Models

Risk Area	Number of Parameters (Approx)
Non-Cat Underwriting Risk	300
Cat Underwriting Risk	??
Reserve Risk	1,000
Credit Risk	50
Market Risk	1,000
Op Risk	500
Dependencies	1,000
SII Balance Sheet	2,000
Total (excl Cat)	**5,850**

Based on relatively common GI capital model methodologies, assuming

- 30 lines of business
- 3 currencies
- 10 prior years
- 30 op risks
- etc

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GI Capital Model Survey

We informally asked a number of respected capital actuaries for their experiences of over complex models…

WARNING
A number of opinions of individuals are expressed.
They are not necessarily our own.
You may not agree with them.
Some don't agree with each other!

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Examples in GI capital models

- Big correlation matrices
- Stochastic cashflows
- Stochastic expense models (not just ulae)
- Modelling every reinsurance feature
- Detailed inflation models
- Stochastic emergence patterns
- Detailed modelling of management actions
- Granular operational risk models
- Stochastic elasticity models – rates vs volumes
- Detailed models of IBNER and IBNR
- Clash modelling
- Risk Margin

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Differences of opinion

Modeling all PPOs individually

- Slow, a lot of effort, detailed and complex;
- But actually difficult to come up with a reasonable approximation…
- … and if we do, lots of effort to justify the approximation is reasonable!
- The methodology is conceptually simple – just lots of data.
- But some big assumptions – propensity, mortality, ASHE index…

Similarly → Modeling all assets individually vs a high level portfolio of proxy assets

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Why does it happen?

- Own exuberance (but then we learn reality)
- Pet projects, not considering the big picture
- Heard mentality
- External pressures – e.g. reserving department
- Being too accepting

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Biggest theme - granularity

"We reserve with 100 classes and 4 currencies, so we should set up the capital model the same way"

"Can you give me the parameters for that please?

"Lets just use the same parameters for each currency"

"And the correlations?..."

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Big Correlation Matrices

- Example inspired and verified in real life internal models
- 100 lines of business non-cat losses of different sizes
- Different means and coefficient of variations
- 100 x 100 correlation matrix = 4950 parameters
- Gaussian copula
- Rank Correlation parameters between 0% and 55%
- Compare aggregate loss distribution against that from
  - Randomly permuted correlation matrix
  - Uniform average correlation of 15%
  - Gumbel copula with correlation 15%

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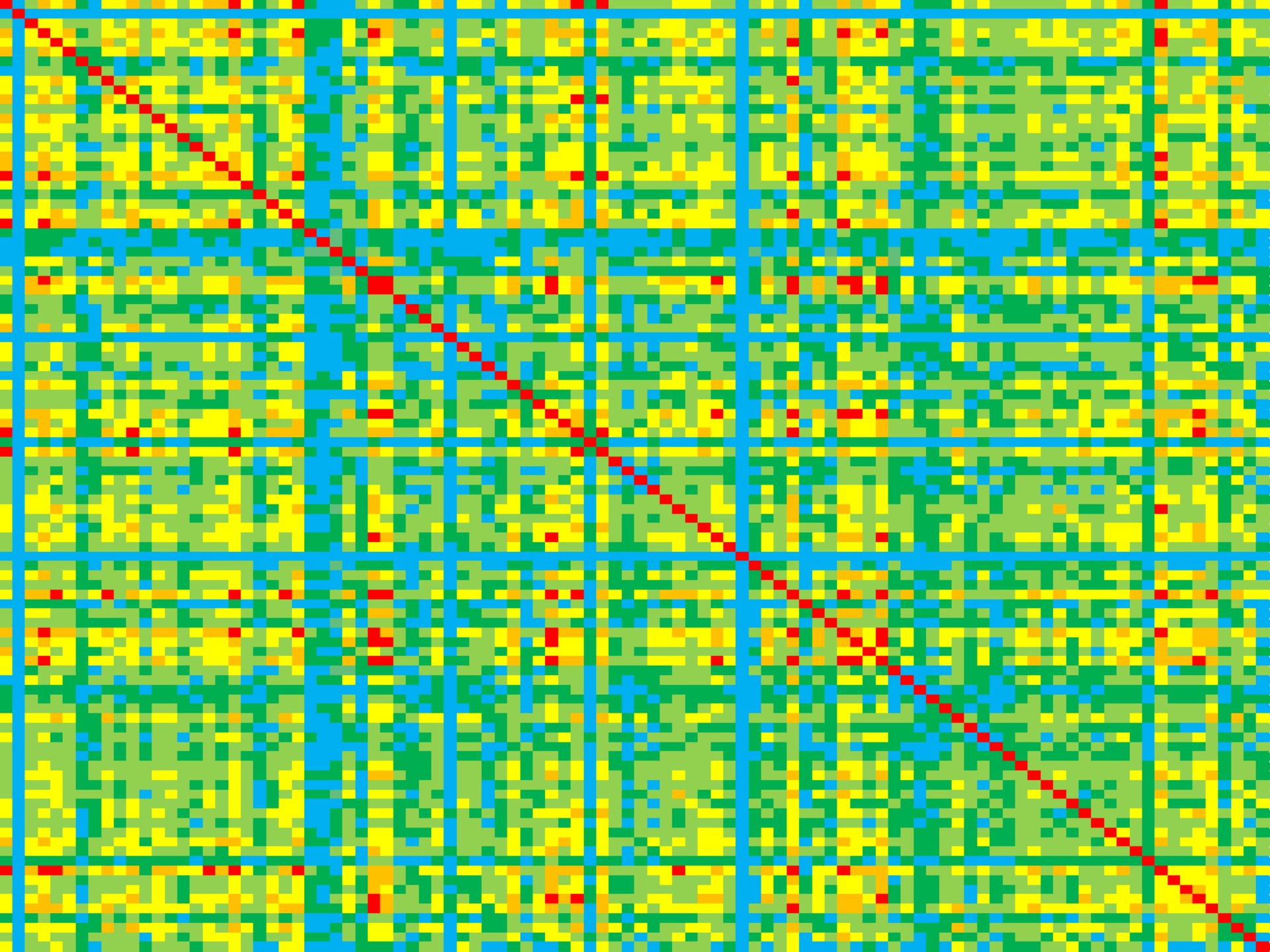

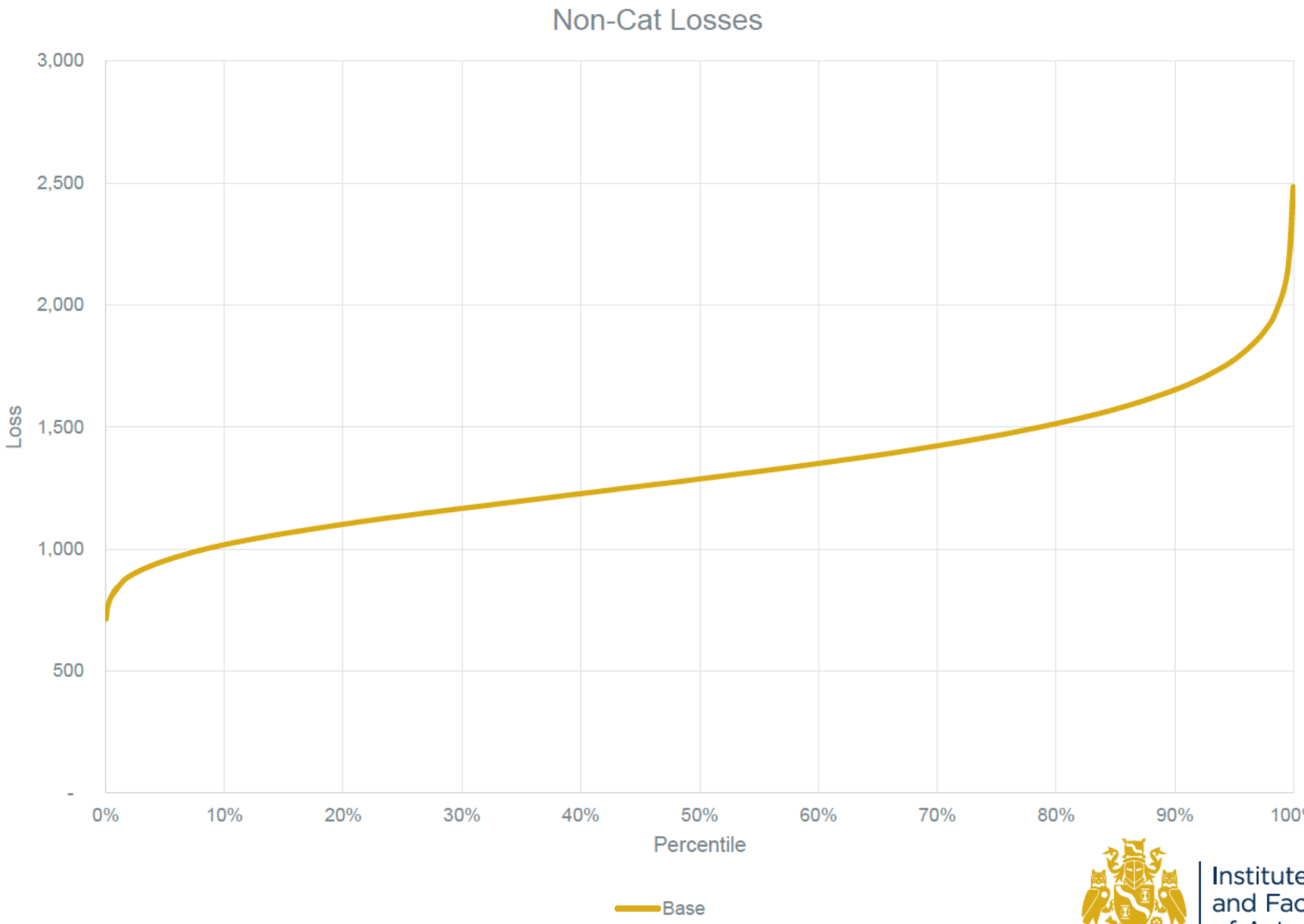

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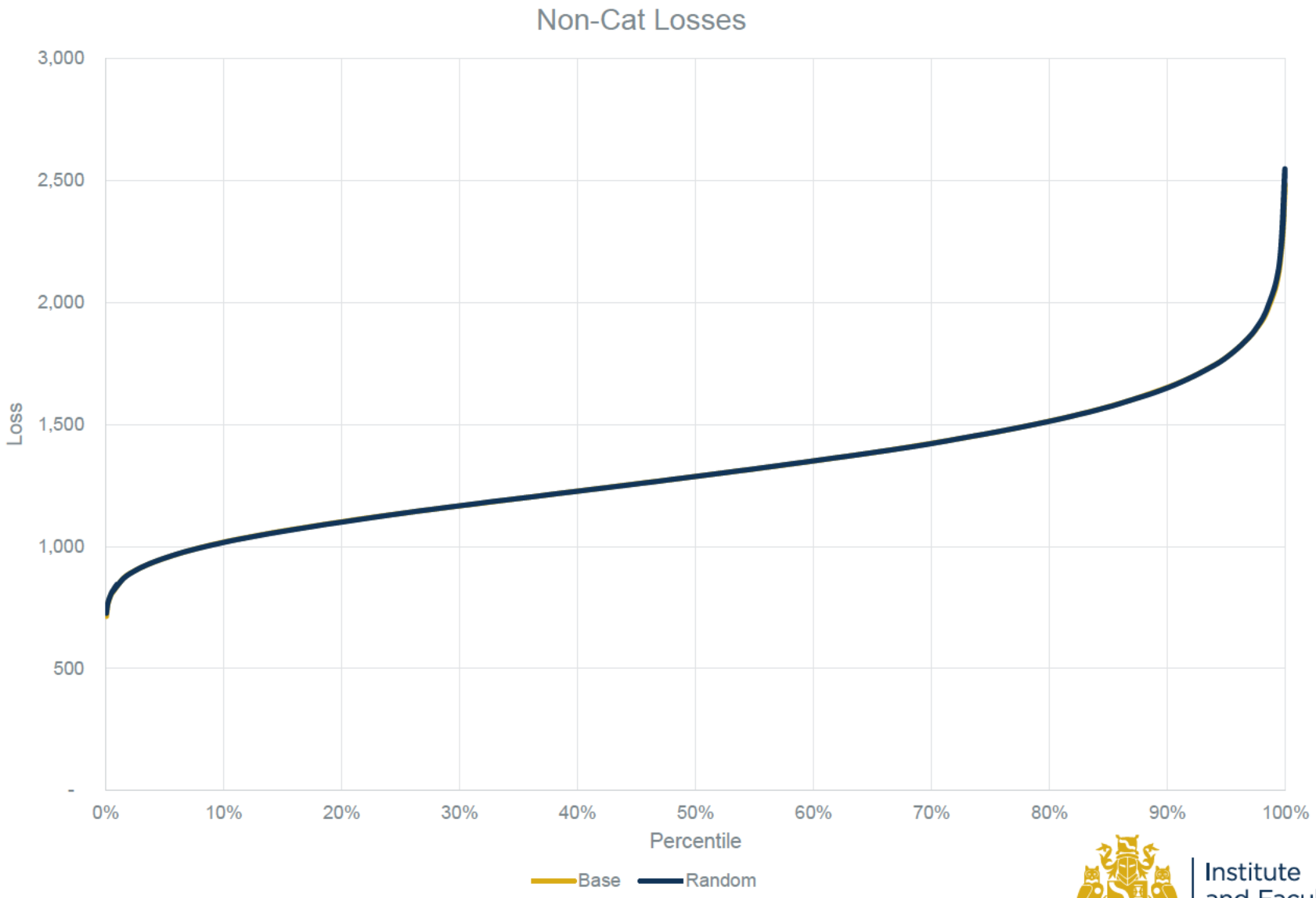

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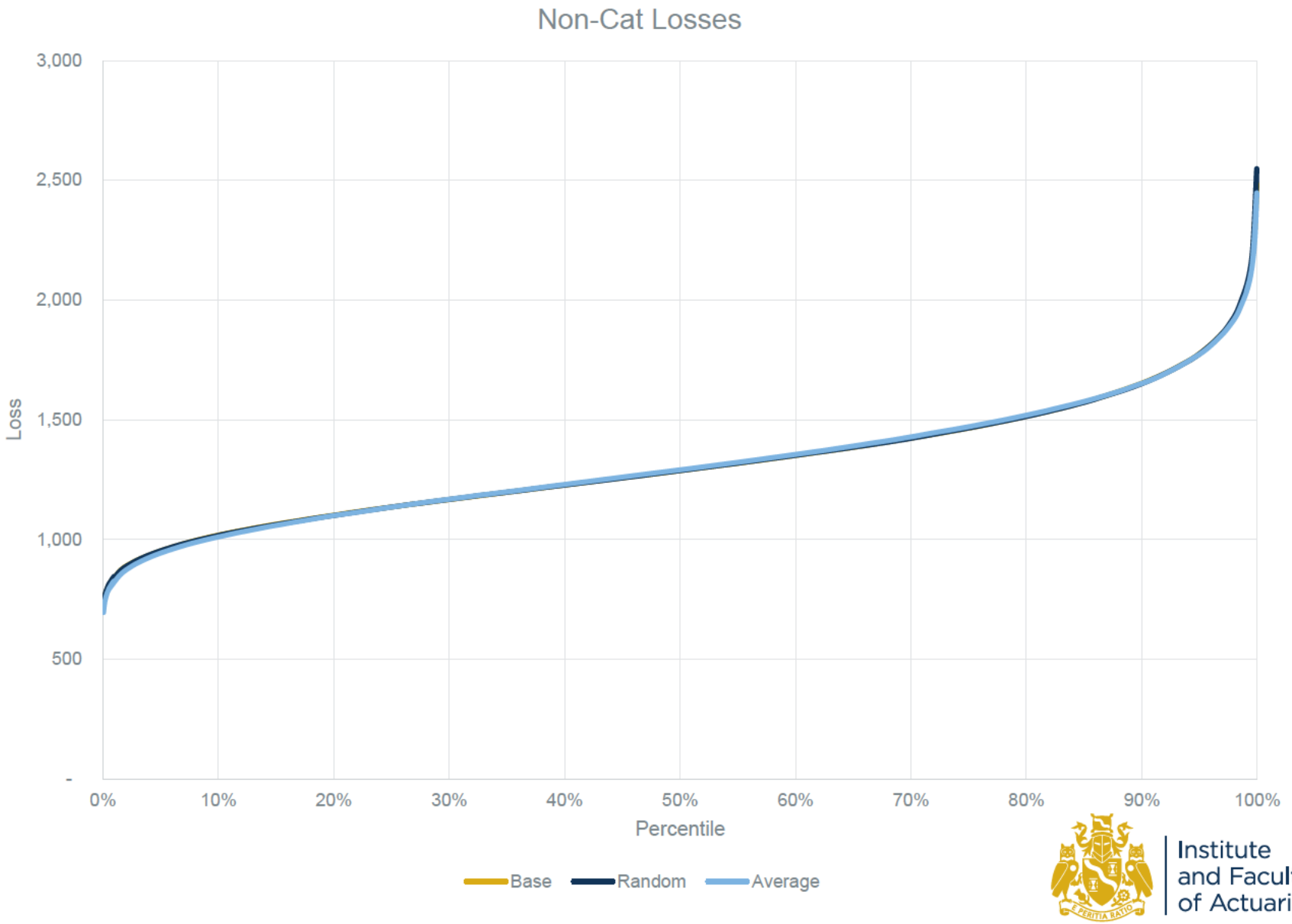

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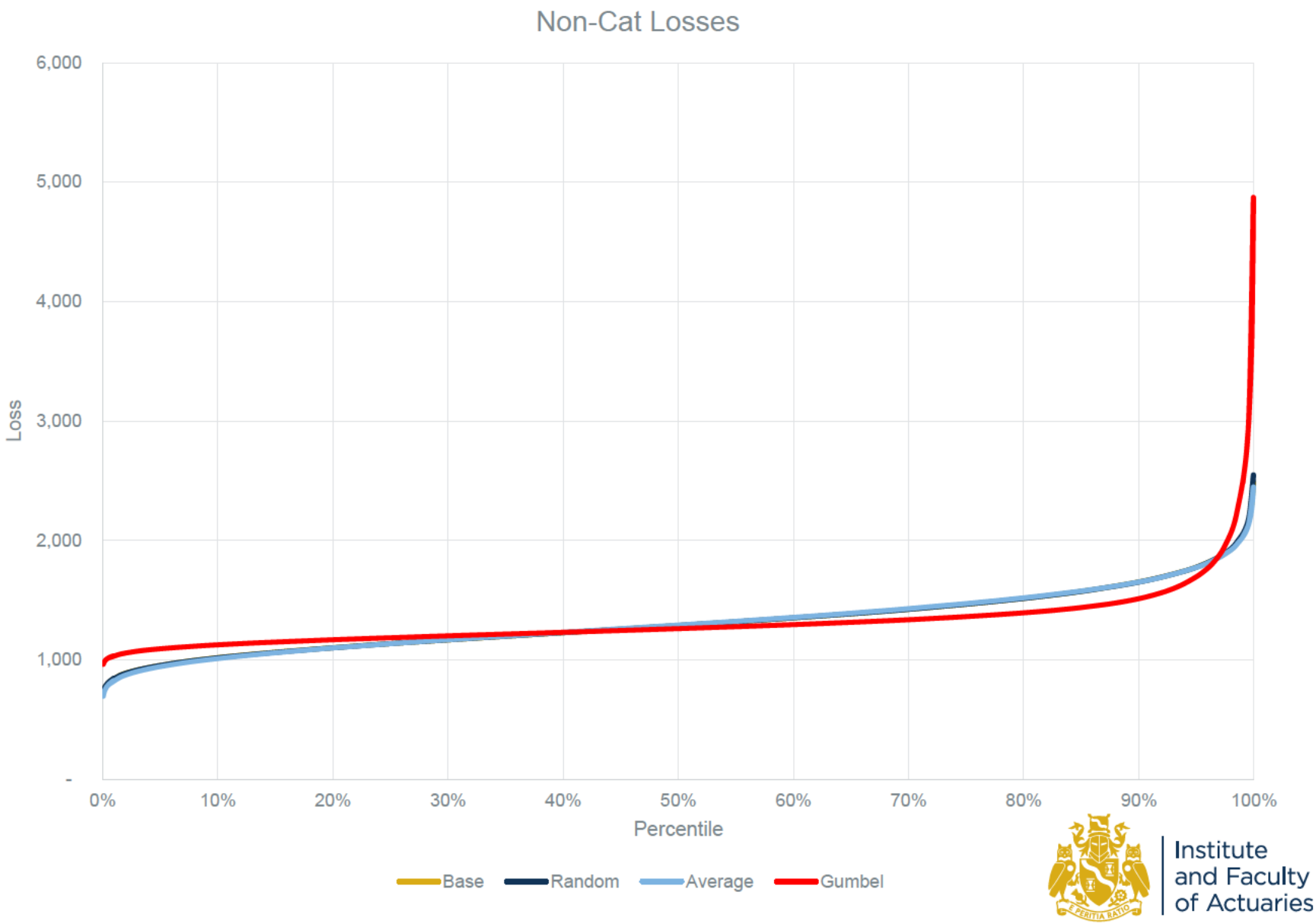

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Big Correlation Matrices Summary

- A fun tongue-in-cheek example
- Seems a universal feature of **large** correlation matrices in **GI capital models** that the individual correlations don't much in terms of **overall capital**, but the average does
- Why does it work?
- Can get same overall result with **single assumption**
  - "It is pointless to do with more what you can do with less"
- Type of copula is much bigger assumption
- Need to think more "Top-Down"

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Where do we go from here?

There is seemingly no limit to how complex an internal model can become

- Be aware of complexity
- Think more “top-down”
- Start simple
- Manage organic growth
- Acknowledge parameter uncertainty
- Professionalism and communication

Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenter.

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