

It Pays to be Bayes:
On Creating Investment-grade
Securities out of Pure Insurance Risk

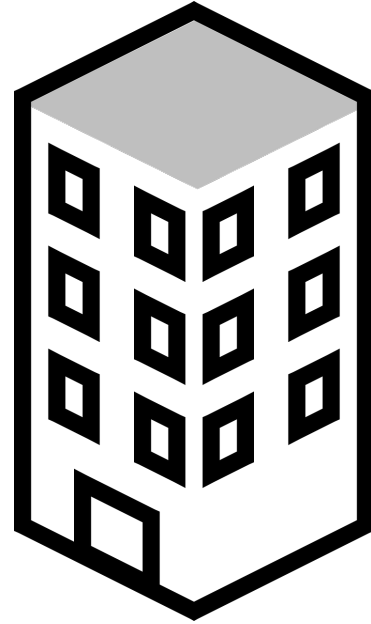
Presented by Nathaniel Haines, PhD

Insurance “just” involves trading calculated risks

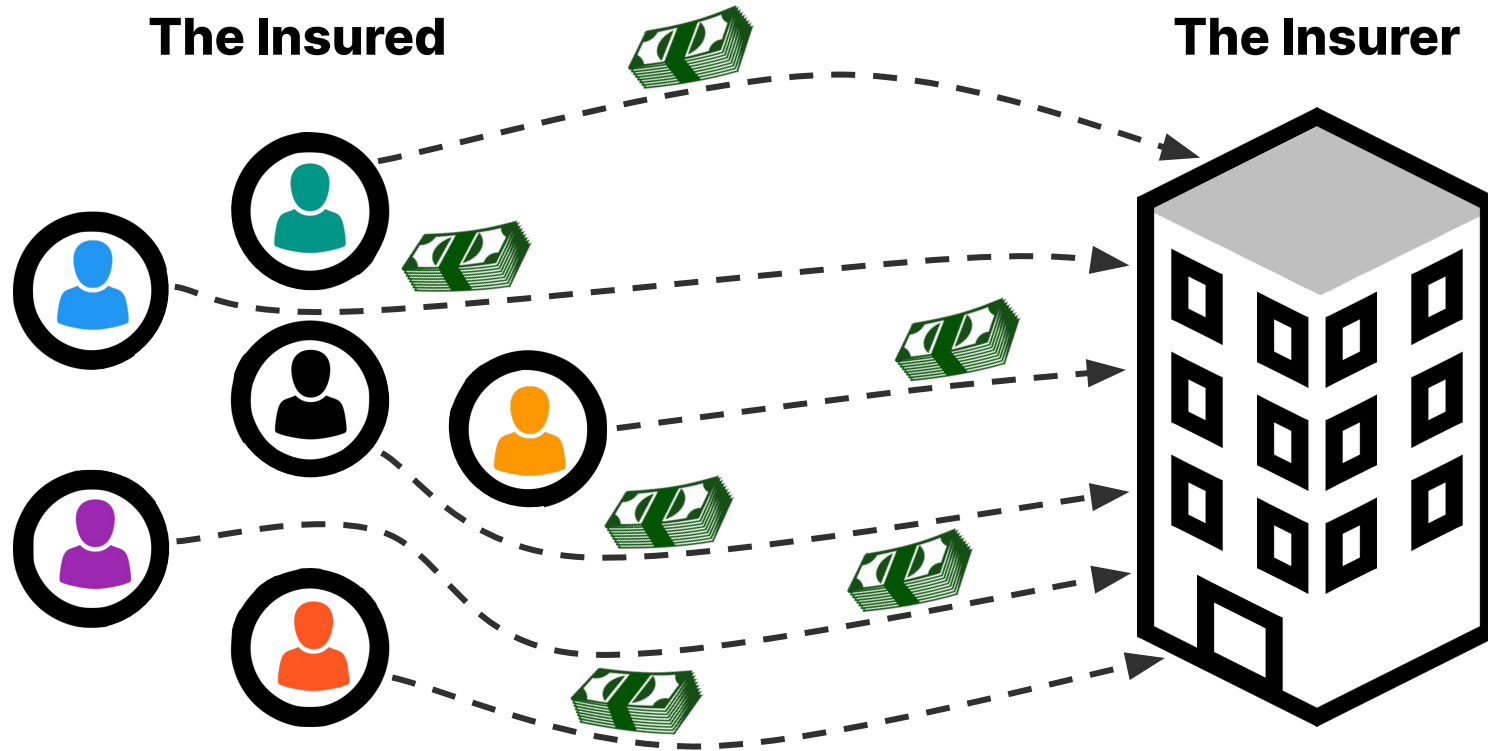
The Insured



The Insurer



Insurance “just” involves trading calculated risks

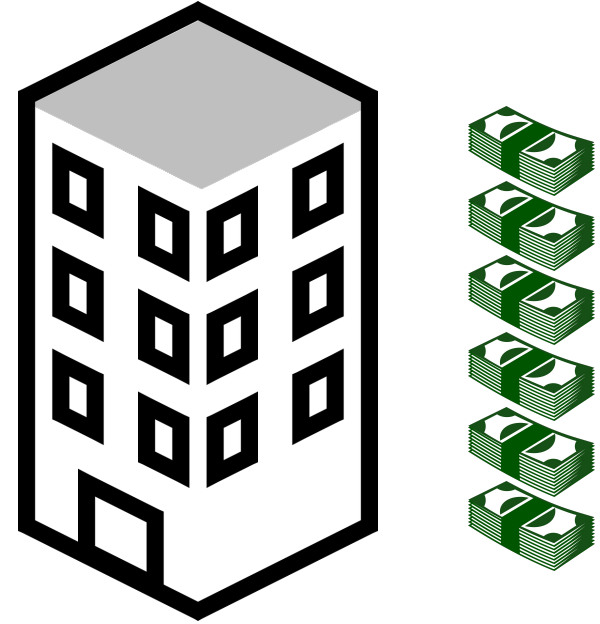


Insurance “just” involves trading calculated risks

The Insured



The Insurer

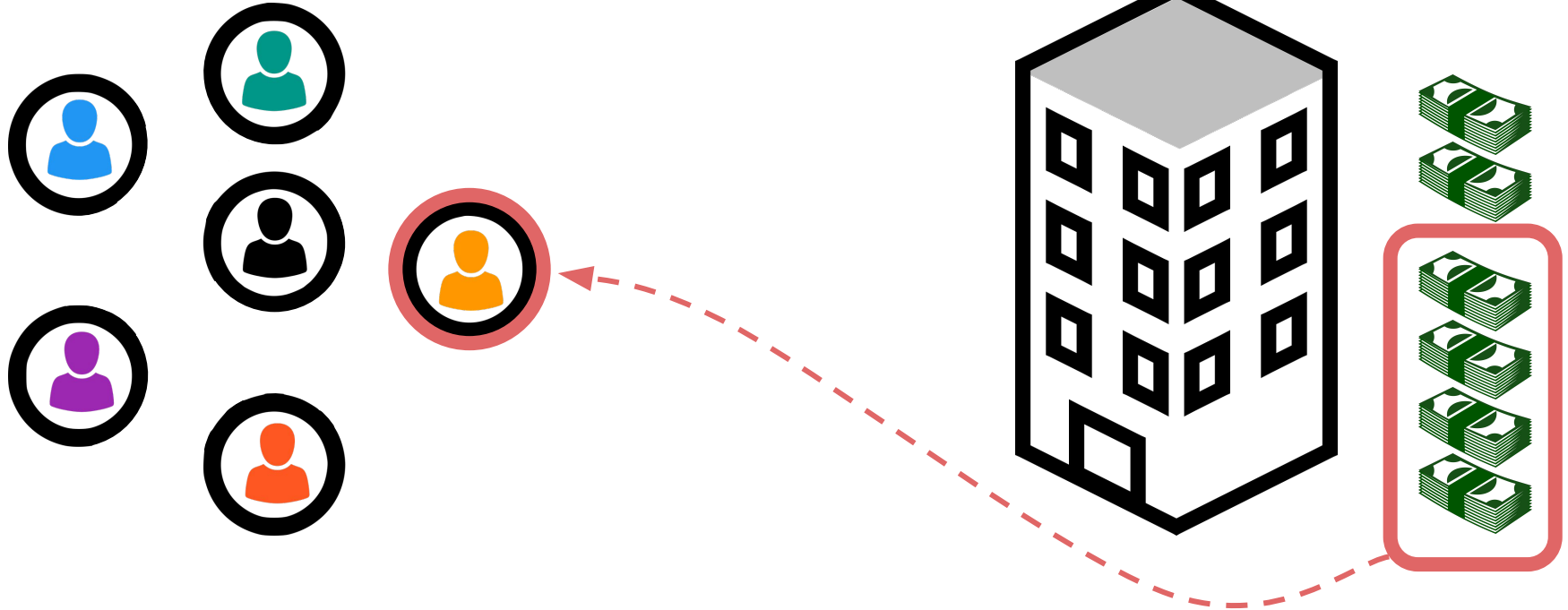


Insurance “just” involves trading calculated risks

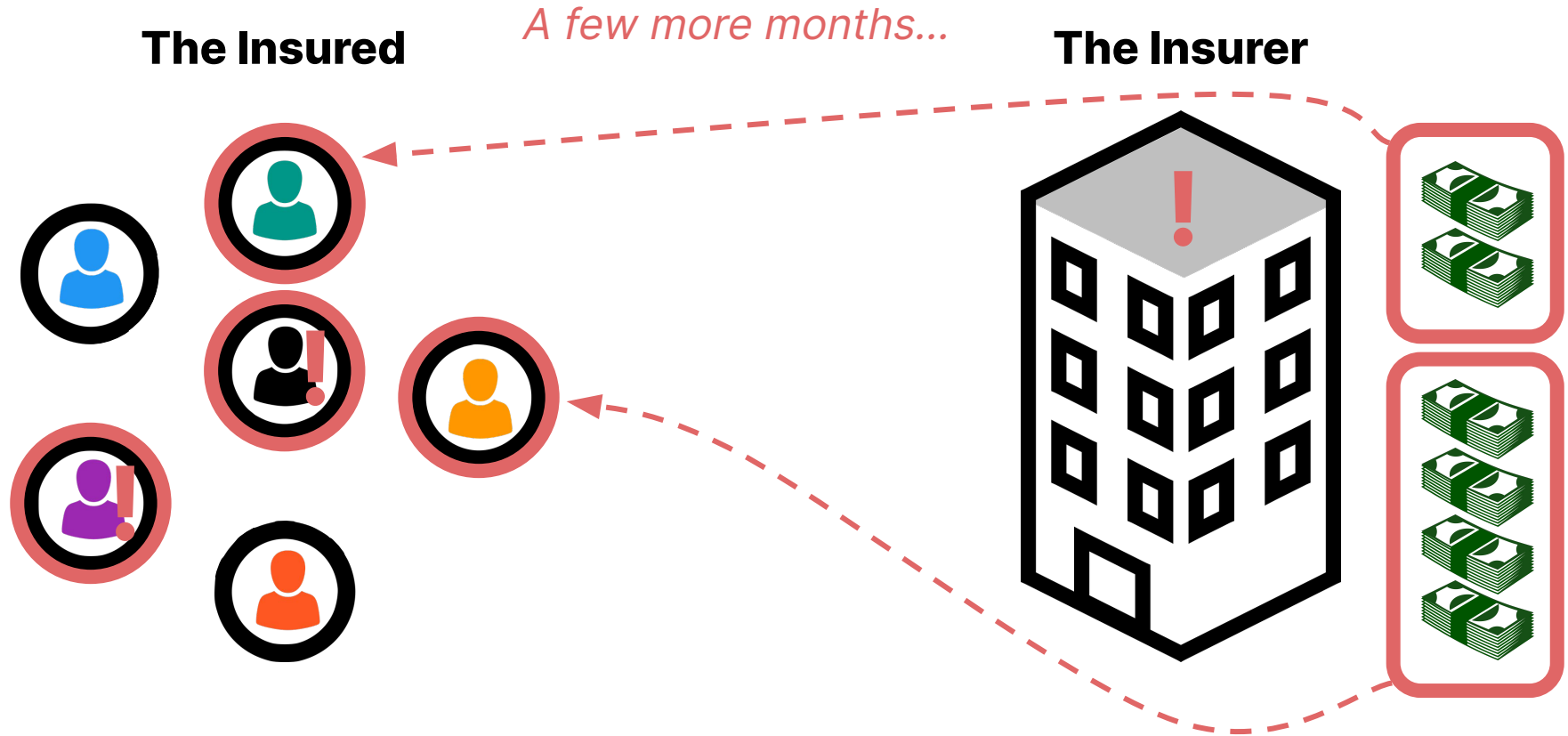
The Insured

A few months later...

The Insurer

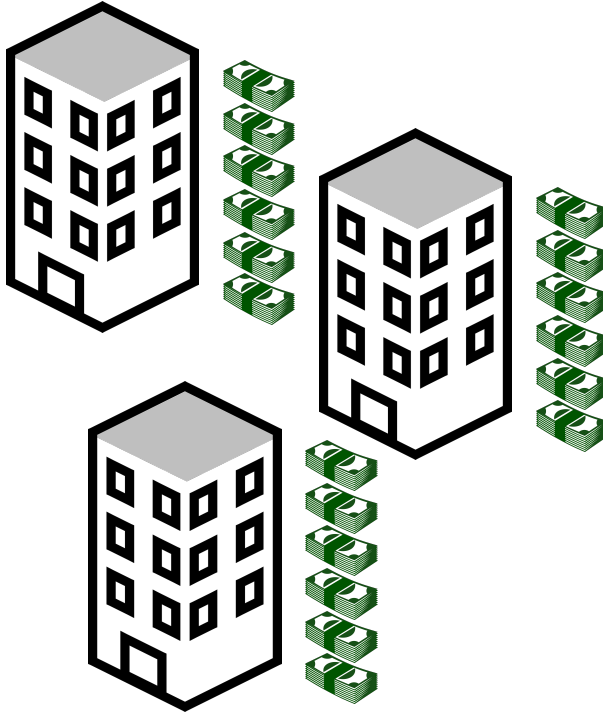


Insurance “just” involves trading calculated risks



Insurance “just” involves trading calculated risks

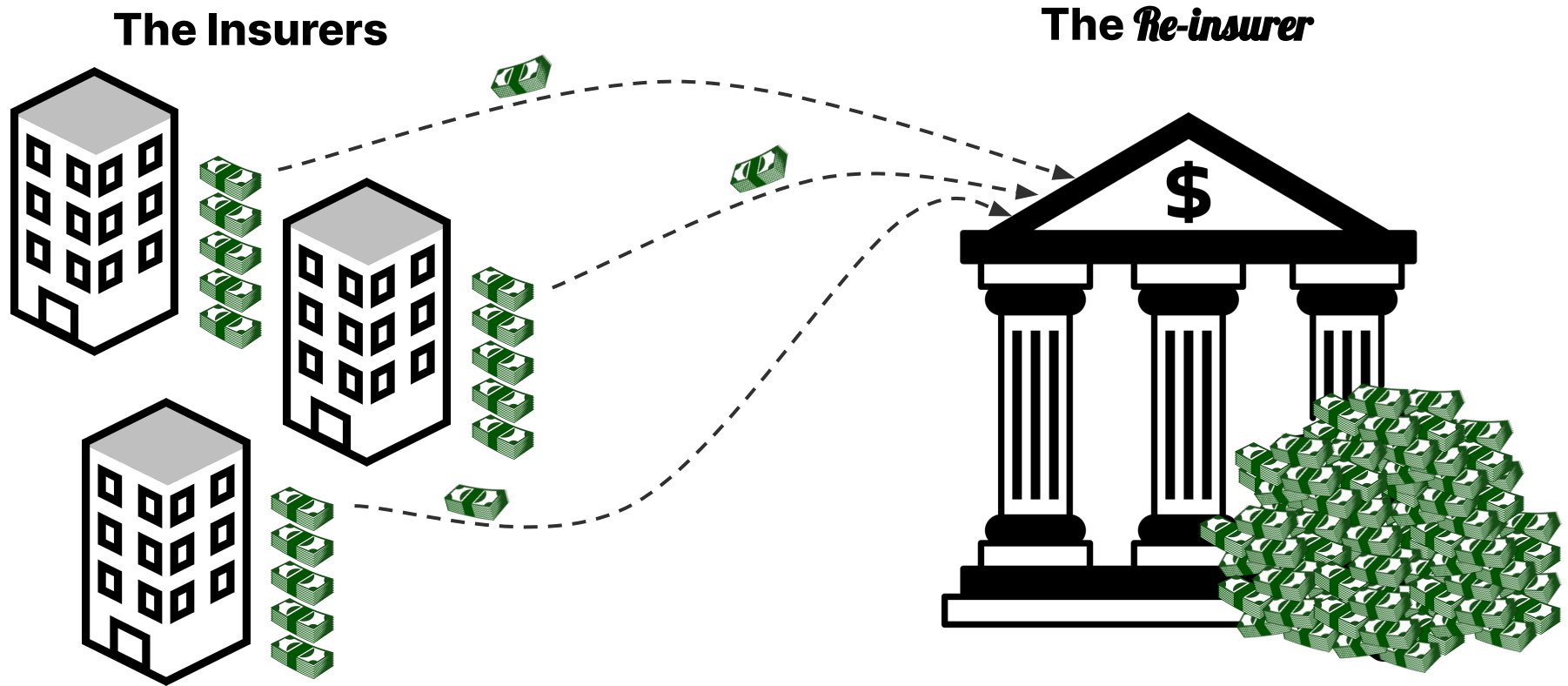
The Insurers



The Re-insurer

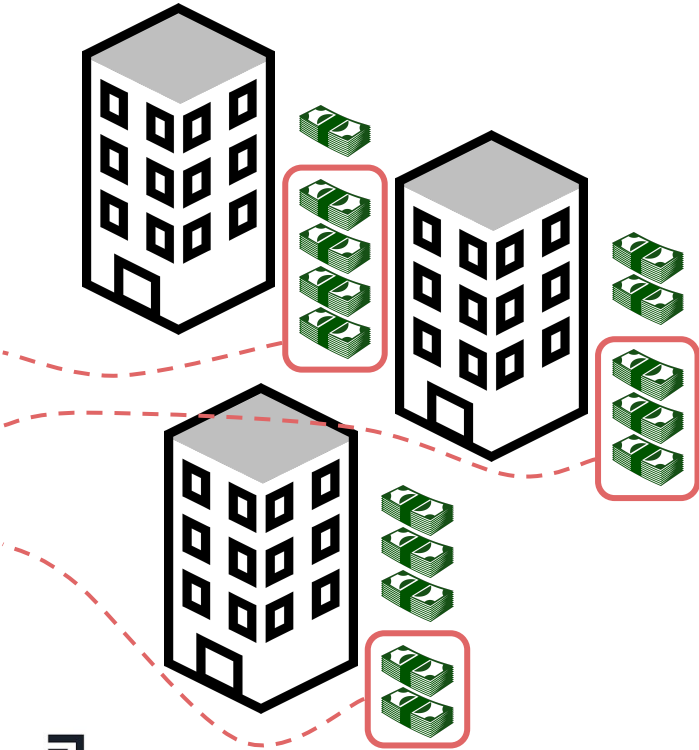


Insurance “just” involves trading calculated risks



Insurance “just” involves trading calculated risks

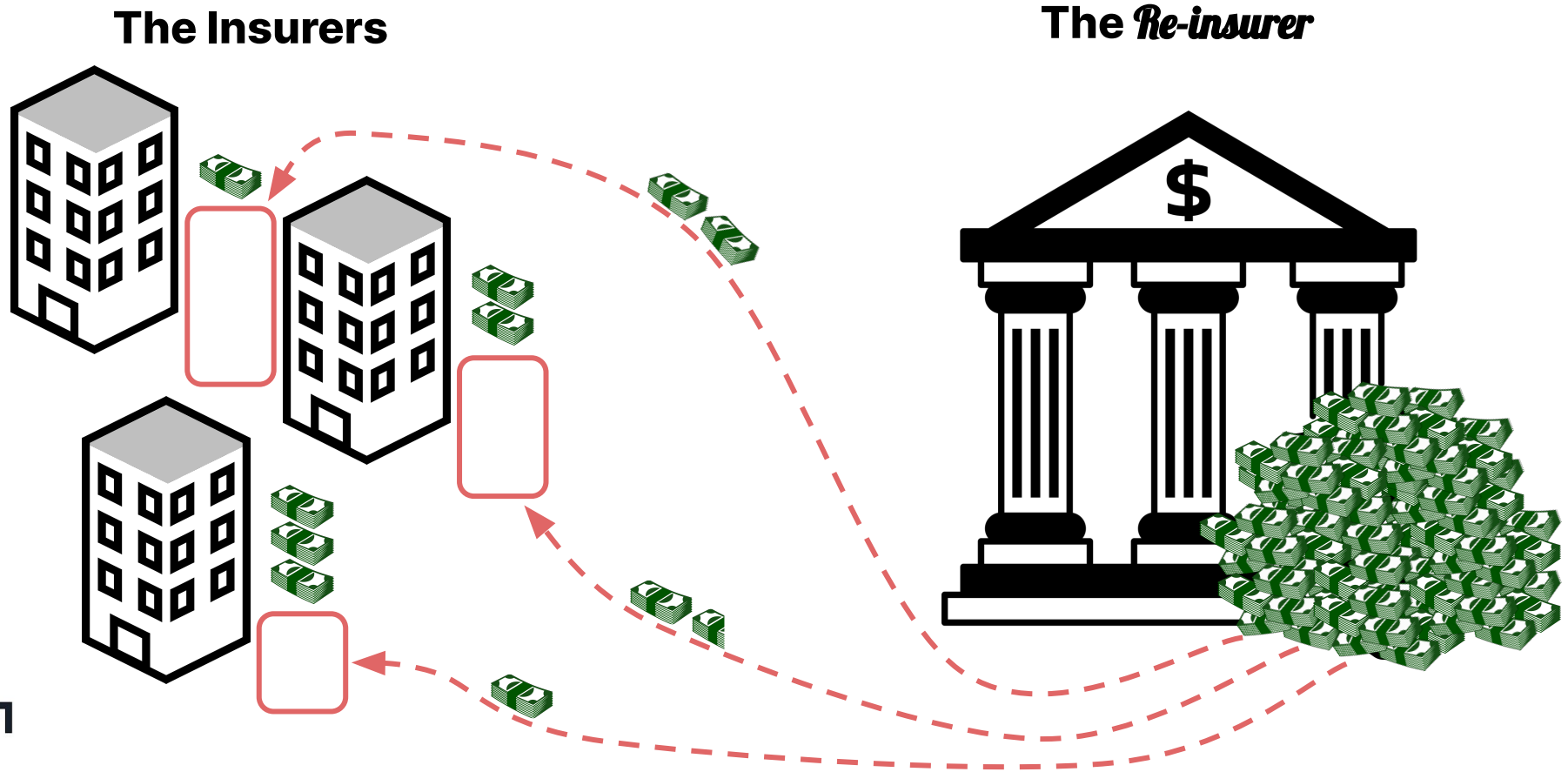
The Insurers



The Re-insurer

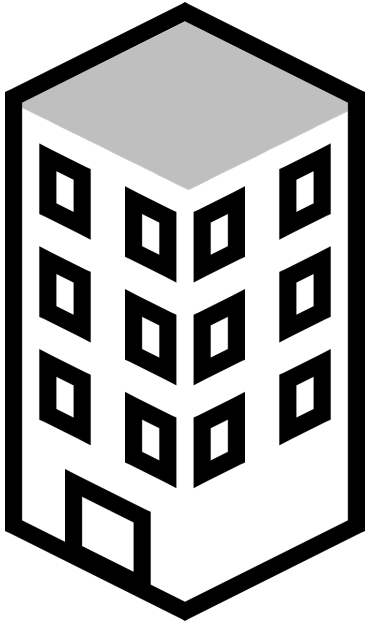


Insurance “just” involves trading calculated risks

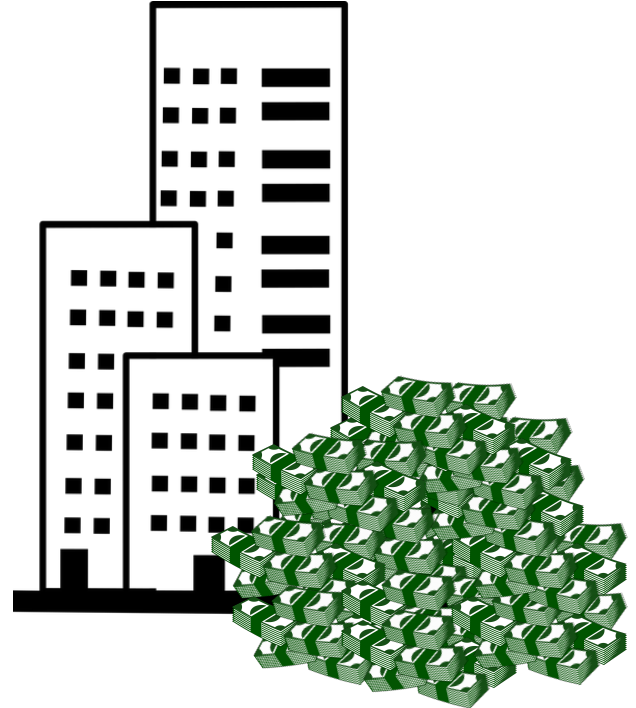


What it means to securitize insurance risk

The Insurer

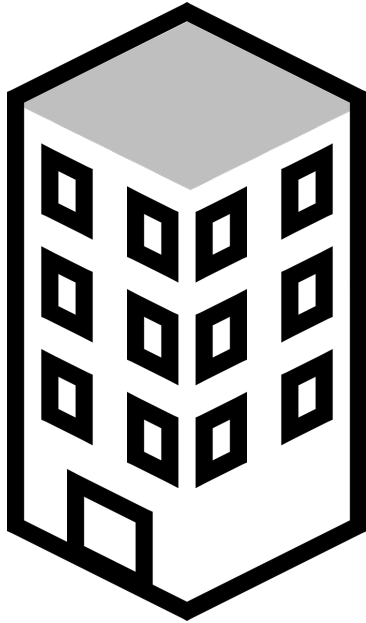


**Institutional
Investor**

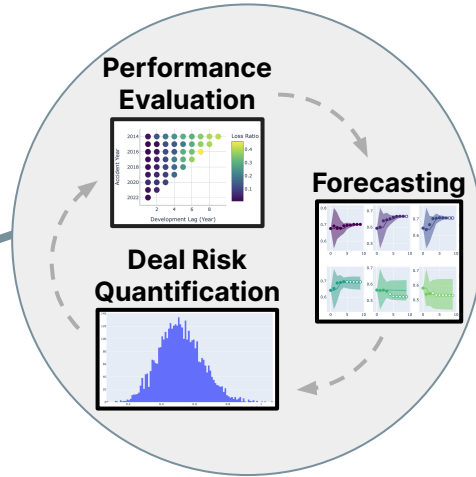


What it means to securitize insurance risk

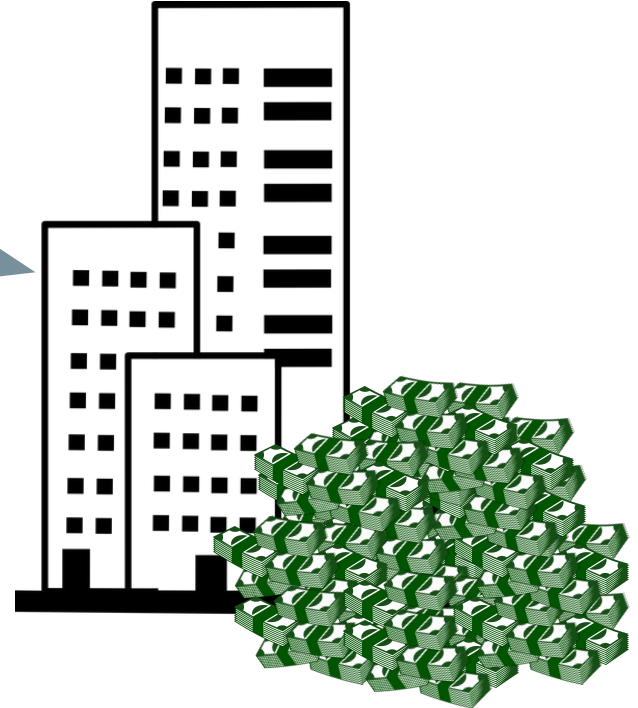
The Insurer



**Ledger
Investing**

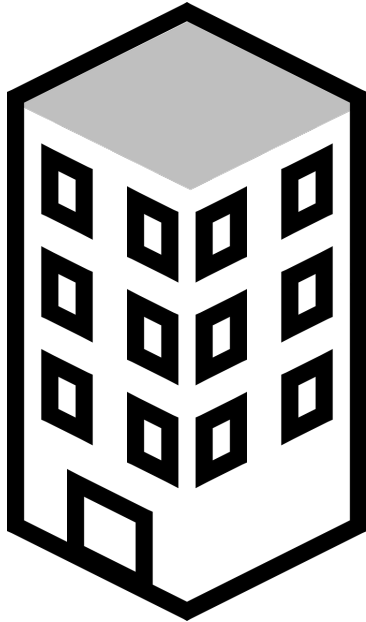


**Institutional
Investor**

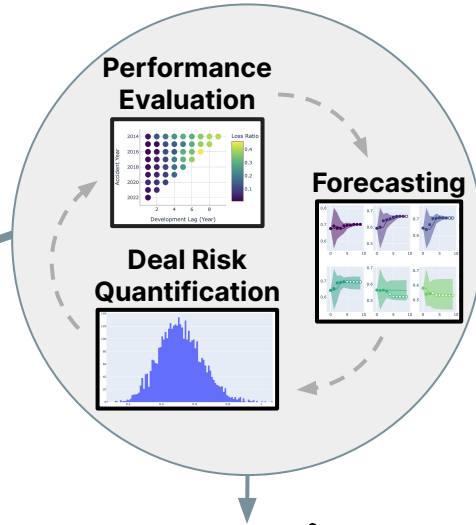


What it means to securitize insurance risk

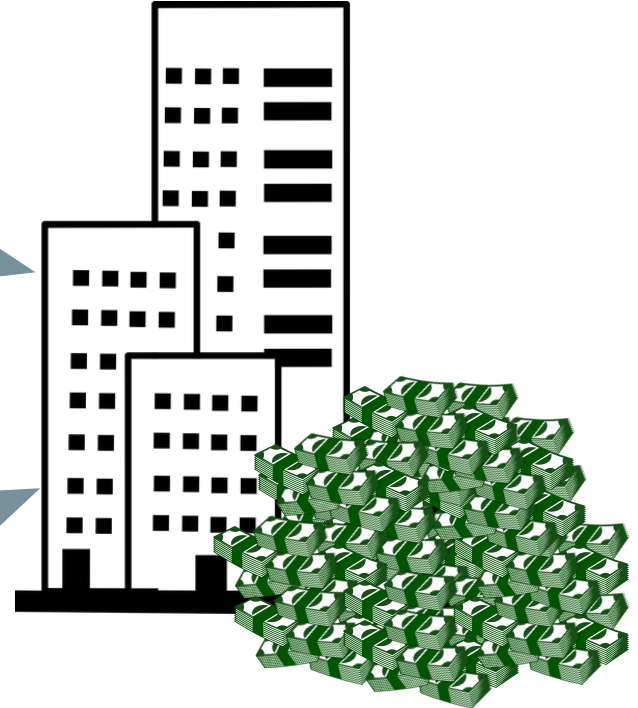
The Insurer



**Ledger
Investing**

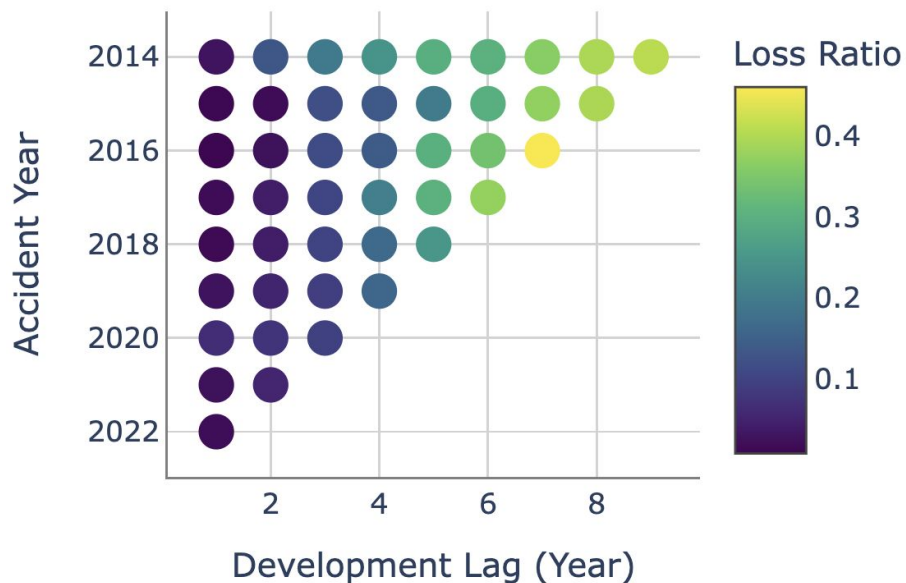


**Institutional
Investor**



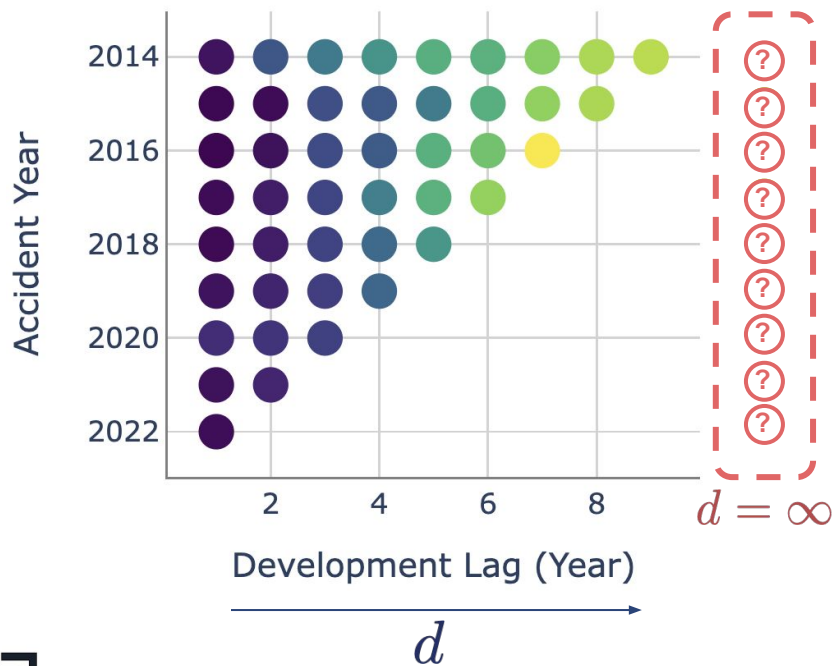
Ledger's Bayesian workflow to measure and forecast insurance risk

Loss Development



Ledger's Bayesian workflow to measure and forecast insurance risk

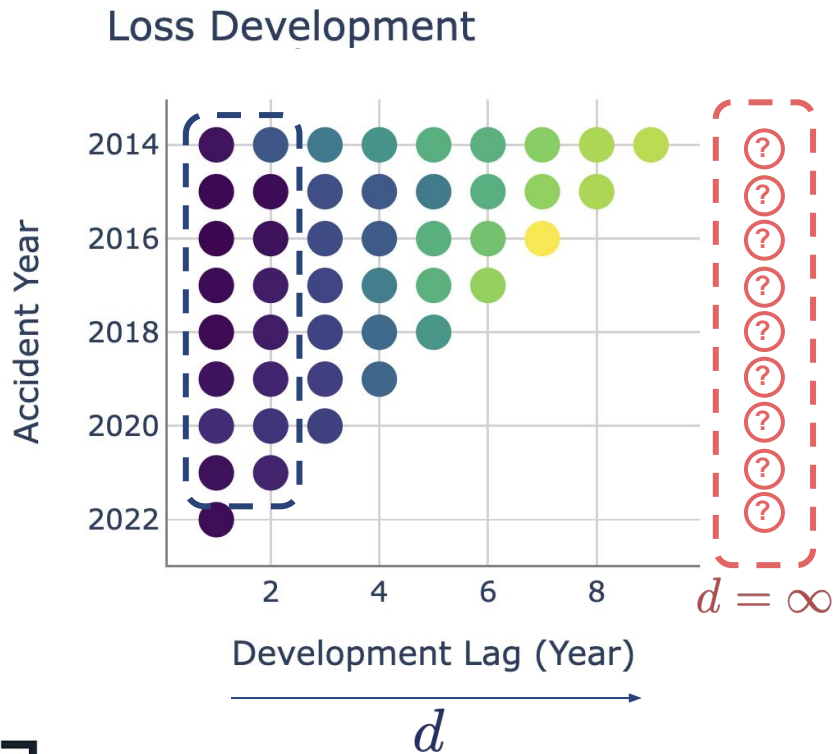
Loss Development



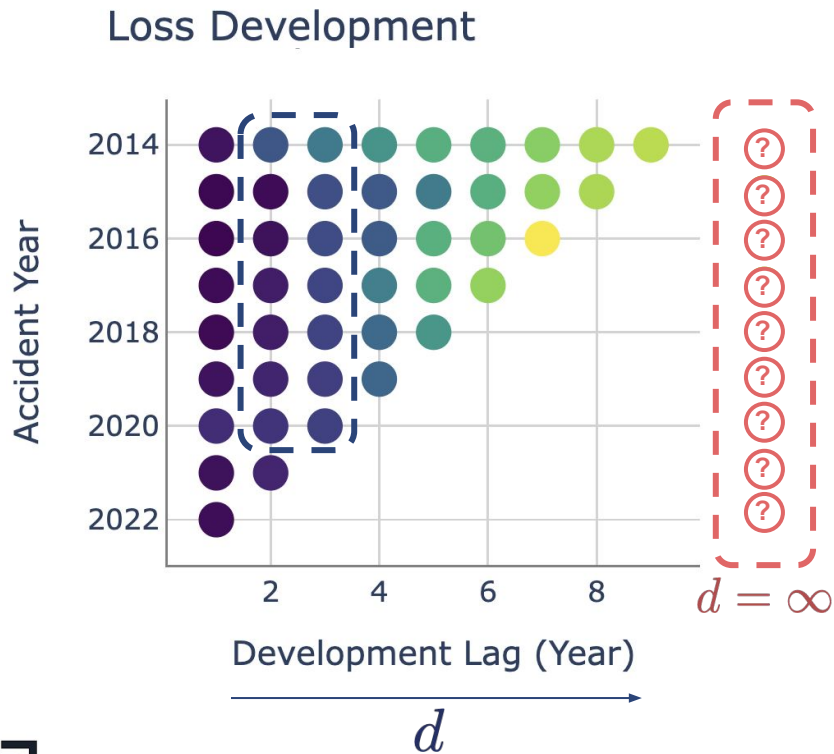
Ledger's Bayesian workflow to measure and forecast insurance risk

The **Traditional** Chain-Ladder Model

$$ATA_1 = 1.2$$



Ledger's Bayesian workflow to measure and forecast insurance risk

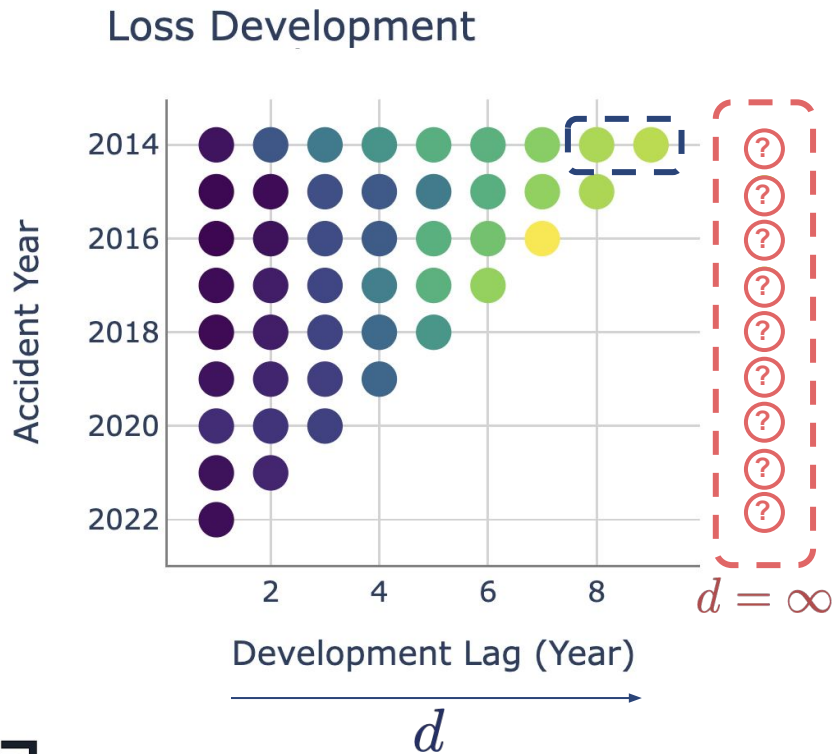


The **Traditional** Chain-Ladder Model

$$\text{ATA}_1 = 1.2$$

$$\text{ATA}_2 = 1.07$$

Ledger's Bayesian workflow to measure and forecast insurance risk



The **Traditional** Chain-Ladder Model

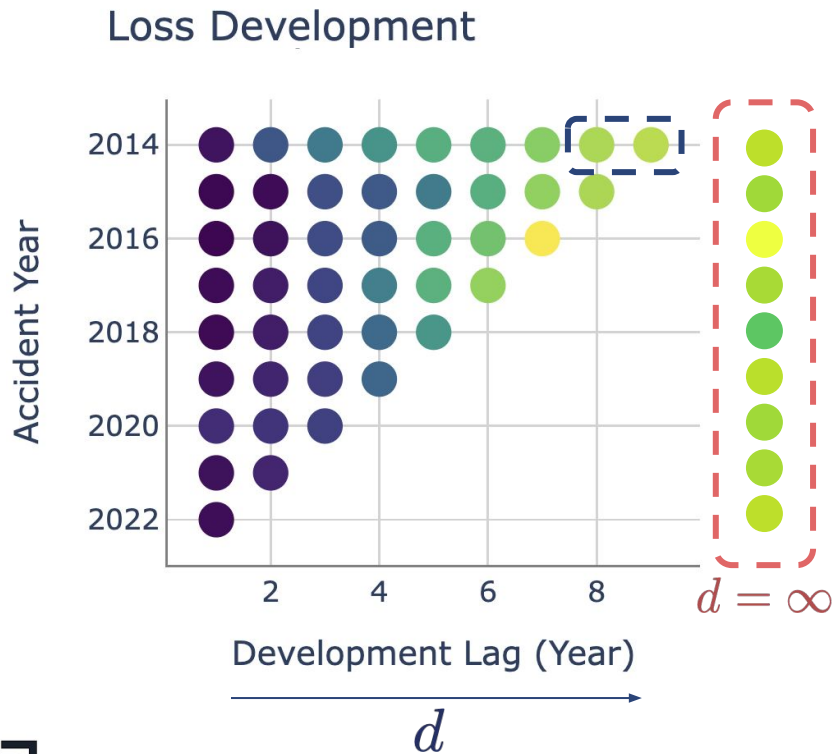
$$ATA_1 = 1.2$$

$$ATA_2 = 1.07$$

...

$$ATA_8 = 1.0$$

Ledger's Bayesian workflow to measure and forecast insurance risk



The **Traditional** Chain-Ladder Model

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$$ATA_2 = 1.07$$

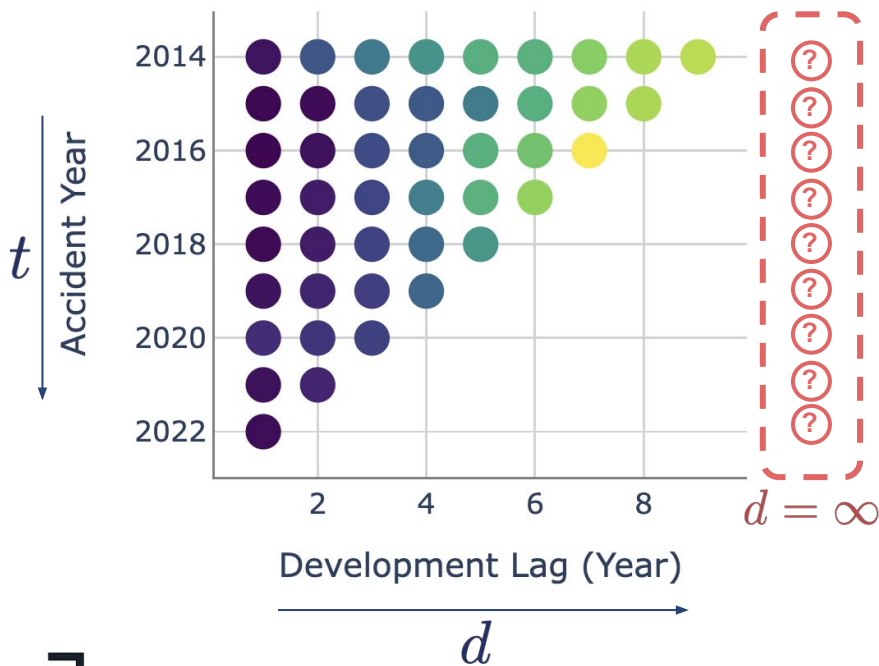
...

$$ATA_8 = 1.0$$

Ledger's Bayesian workflow to measure and forecast insurance risk

The *Bayesian* Chain-Ladder Model

Loss Development



$$\mu_{t,d} = \text{ATA}_d \cdot \text{LR}_{t,d-1}$$

$$\sigma_{t,d} = \exp(\sigma_{\text{int}} - \sigma_{\text{slope}} \cdot [d - 1])$$

Note: Models presented are simplified versions of what we use in production

Ledger's Bayesian workflow to measure and forecast insurance risk



The *Bayesian* Chain-Ladder Model

$$\text{LR}_{t,d} \sim \Gamma(\alpha_{t,d}, \beta_{t,d})$$

$$\alpha_{t,d} = \mu_{t,d}^2 / \sigma_{t,d}^2$$

$$\beta_{t,d} = \mu_{t,d} / \sigma_{t,d}^2$$

$$\mu_{t,d} = \text{ATA}_d \cdot \text{LR}_{t,d-1}$$

$$\sigma_{t,d} = \exp(\sigma_{\text{int}} - \sigma_{\text{slope}} \cdot [d - 1])$$

$$\text{ATA}_d \sim \mathcal{LN}(0, 0.2)$$

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Ledger's Bayesian workflow to measure and forecast insurance risk

The *Bayesian* Chain-Ladder Model

$$LR_{t,d} \sim \Gamma([\mu_t, \sigma_t])$$

$$\alpha_{t,d} = \mu_{t,d}^2 / \sigma_{t,d}^2$$

$$\beta_{t,d} = \mu_{t,d} / \sigma_{t,d}^2$$

$$\mu_{t,d} = ATA_d \cdot LR_{t,d-1}$$

$$\sigma_{t,d} = \exp(\sigma_{\text{int}} - \sigma_{\text{slope}} \cdot [d - 1])$$

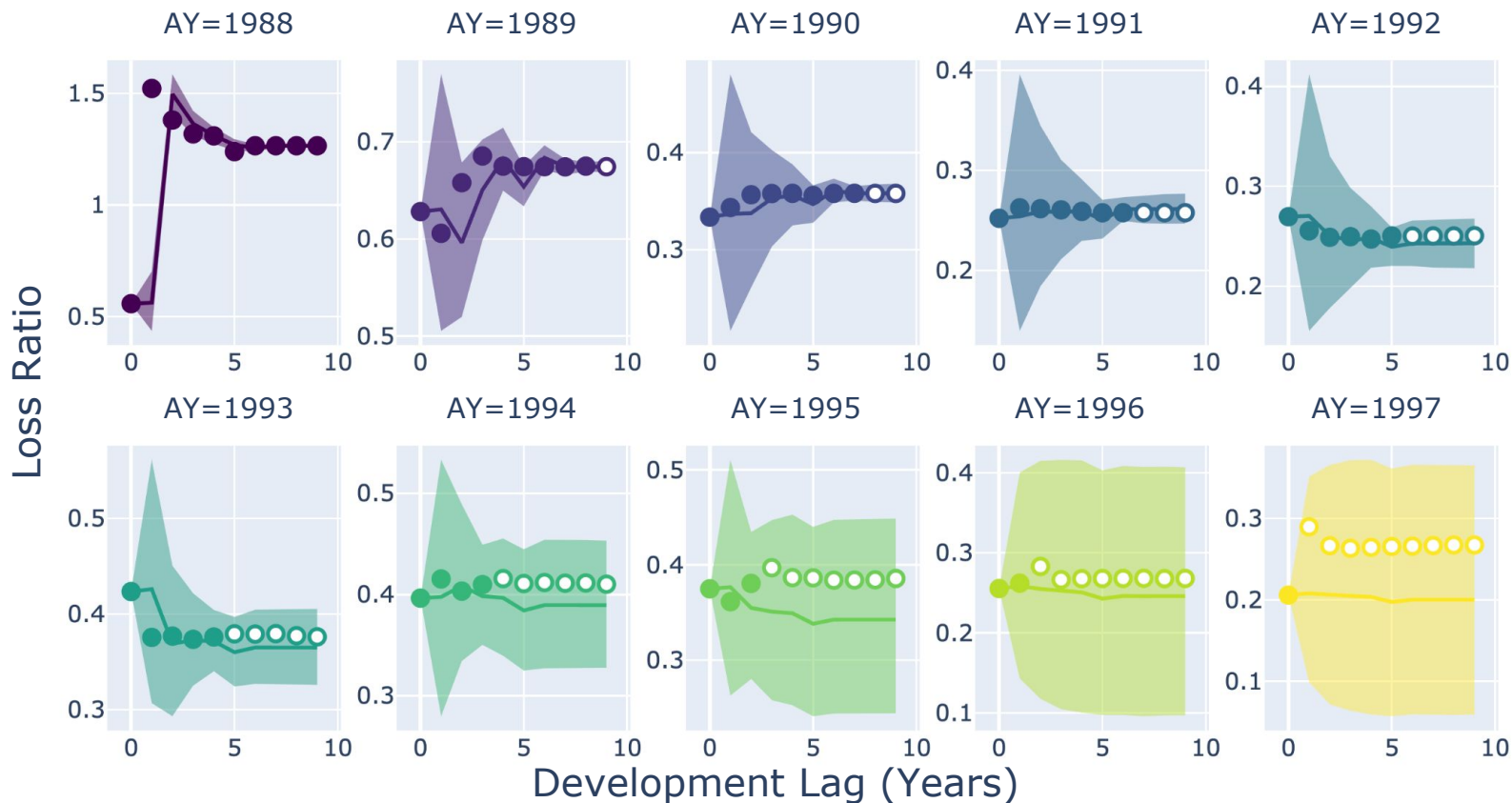
$$ATA_d \sim \mathcal{LN}(0, 0.2)$$



Note: Models presented are simplified versions of what we use in production

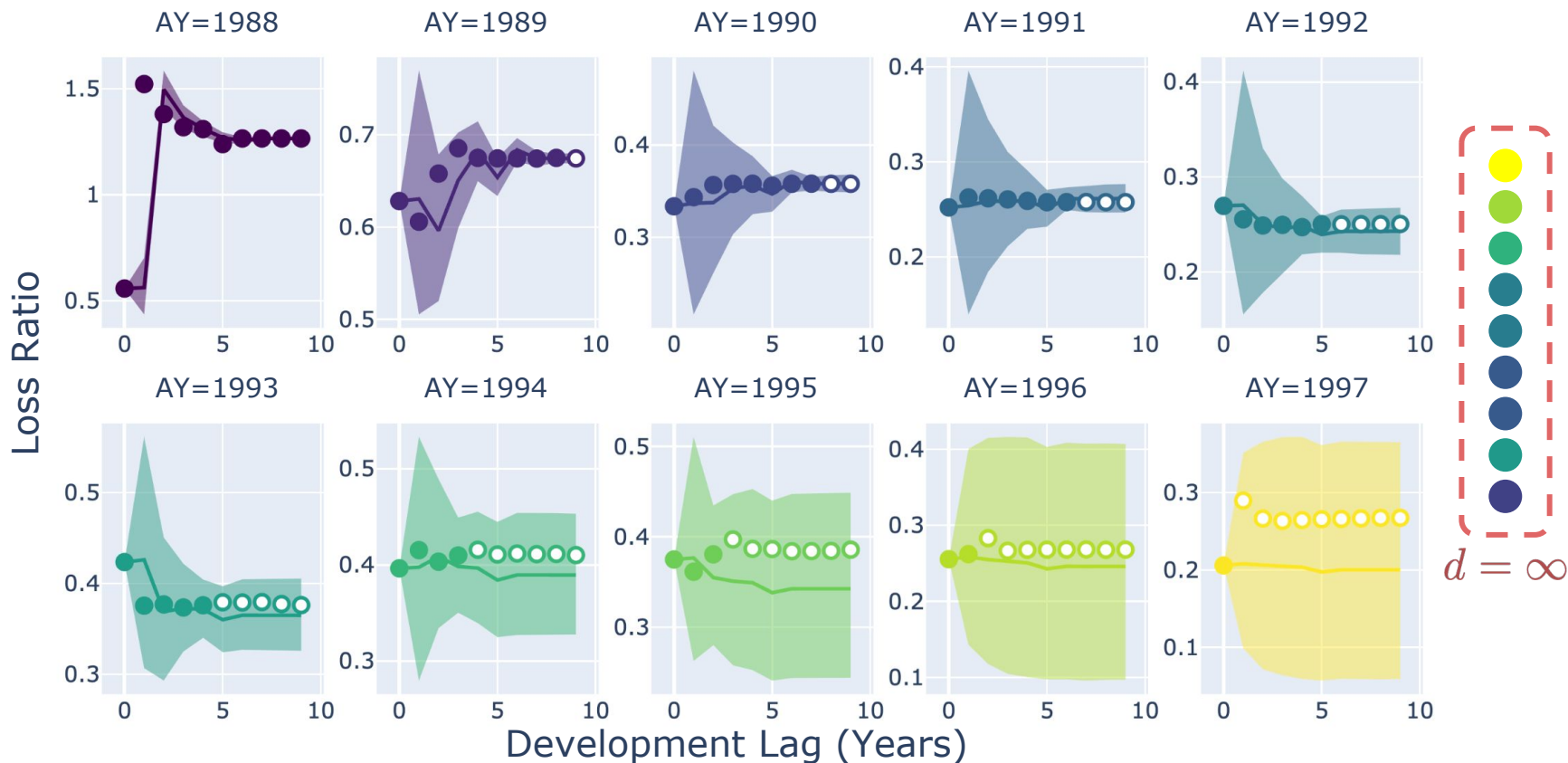
Ledger's Bayesian workflow to measure and forecast insurance risk

Actual Loss Ratios vs "Developed" Posterior Predictions



Ledger's Bayesian workflow to measure and forecast insurance risk

Actual Loss Ratios vs "Developed" Posterior Predictions

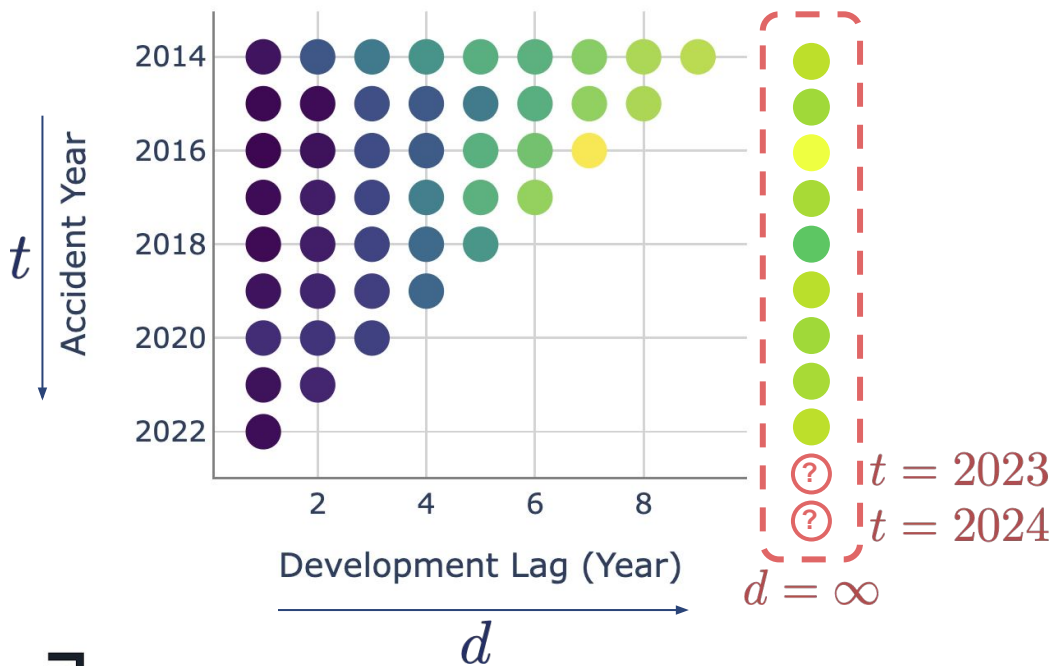


Ledger's Bayesian workflow to measure and forecast insurance risk

On Risk

Loss Forecasting

Loss Development



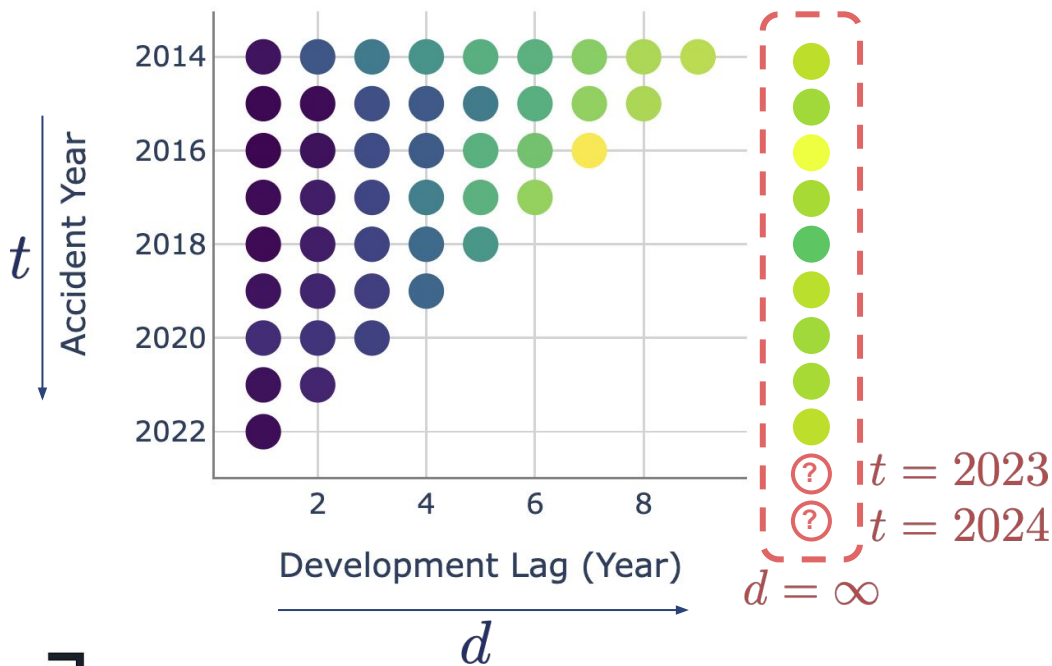
Note: Models presented are simplified versions of what we use in production

Ledger's Bayesian workflow to measure and forecast insurance risk

On Risk

Loss Forecasting

Loss Development



$$\mu_t = \phi \cdot \text{LR}_{\text{true},t-1} + (1 - \phi)\mu$$

$$\sigma_t = \exp(\sigma_{\text{int}} + \sigma_{\text{slope}}/\text{Premium})$$

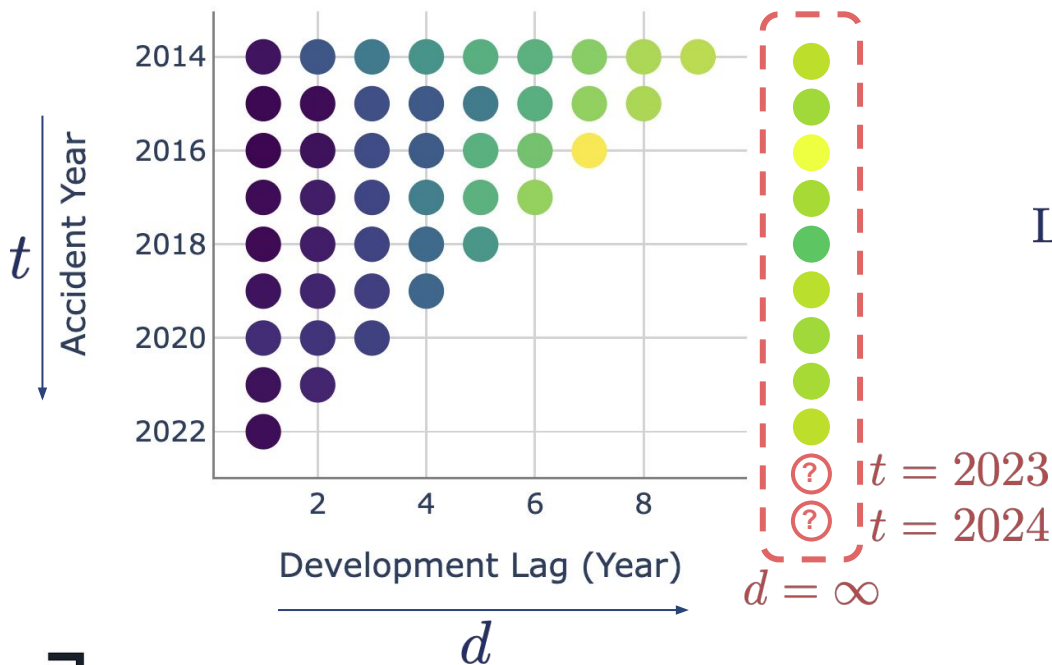
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Ledger's Bayesian workflow to measure and forecast insurance risk

On Risk

Loss Forecasting

Loss Development



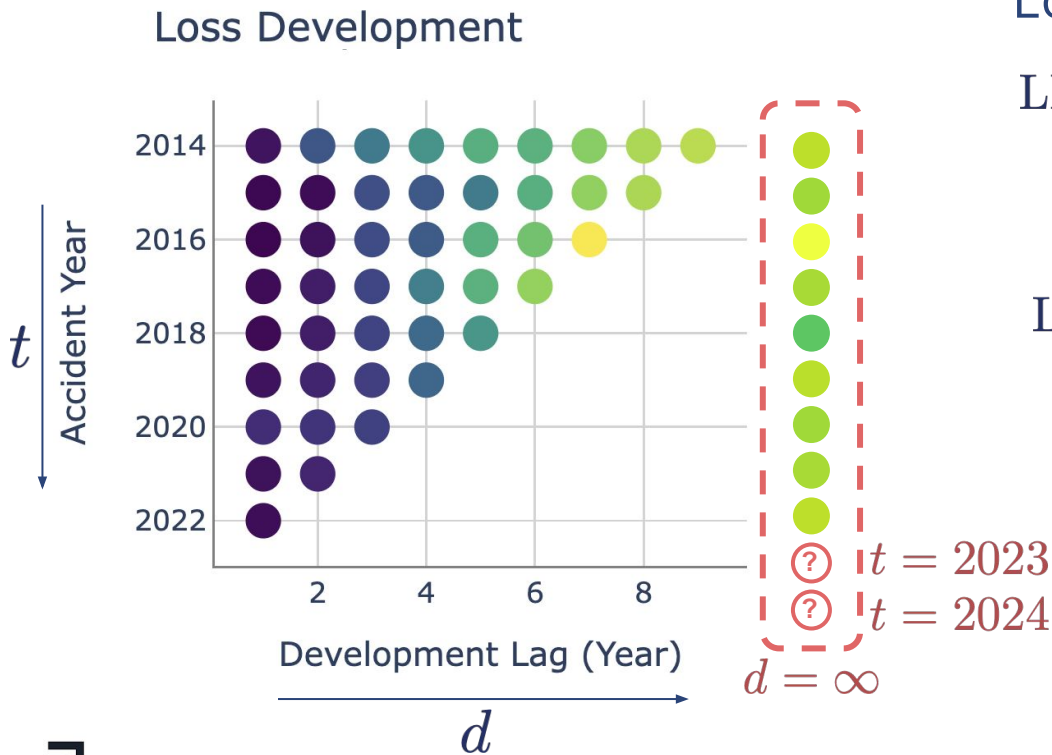
$$\mu_t = \phi \cdot \text{LR}_{\text{true},t-1} + (1 - \phi)\mu$$

$$\sigma_t = \exp(\sigma_{\text{int}} + \sigma_{\text{slope}}/\text{Premium})$$

$$\text{LR}_{\text{obs},t} \sim \Gamma([\text{LR}_{\text{true},t}, \text{SD}(\text{LR}_{\text{obs},t})])$$

Note: Models presented are simplified versions of what we use in production

Ledger's Bayesian workflow to measure and forecast insurance risk



On Risk

Loss Forecasting

$$\text{LR}_{\text{true},t} \sim \Gamma([\mu_t, \sigma_t])$$

$$\mu_t = \phi \cdot \text{LR}_{\text{true},t-1} + (1 - \phi)\mu$$

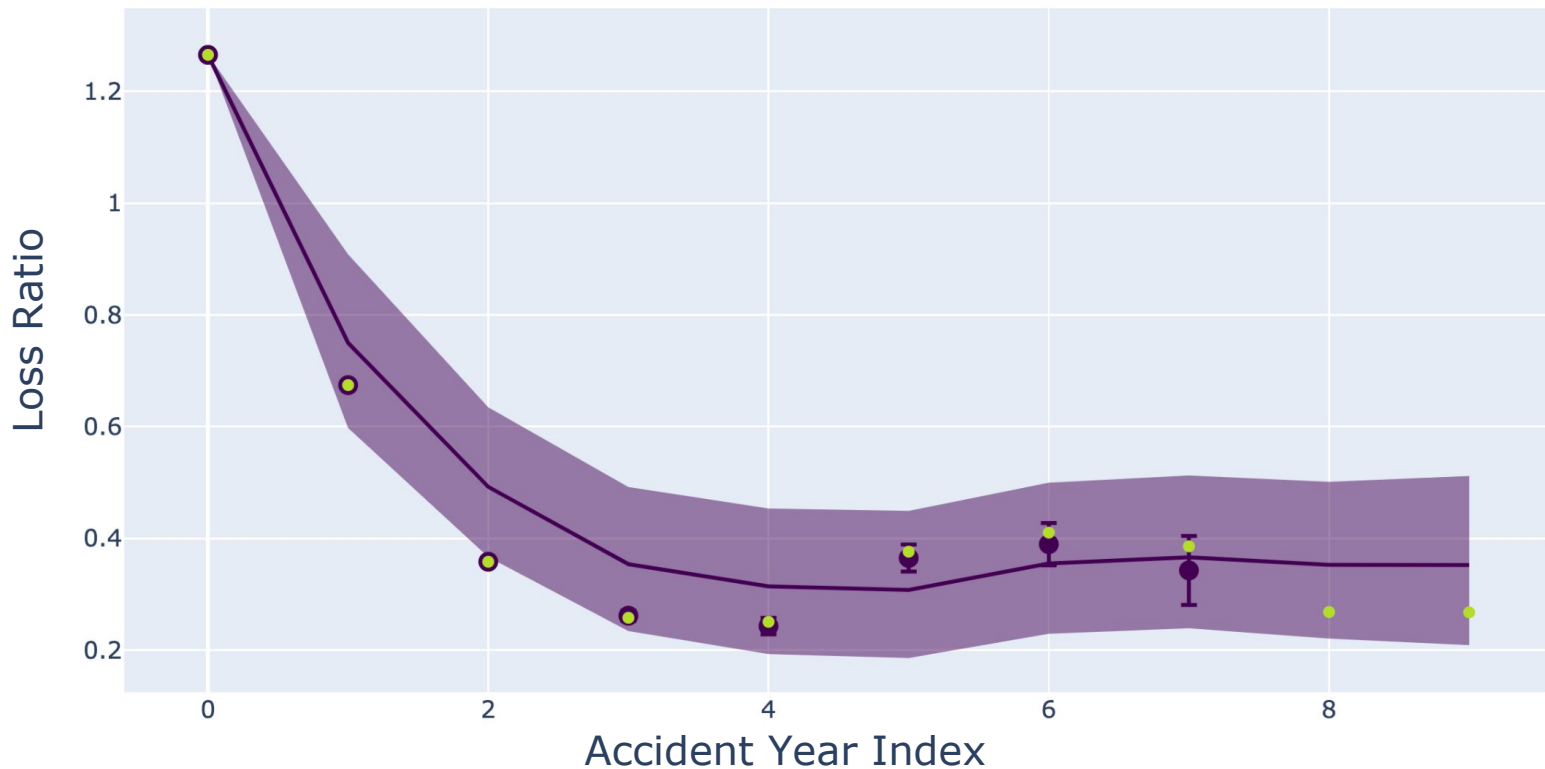
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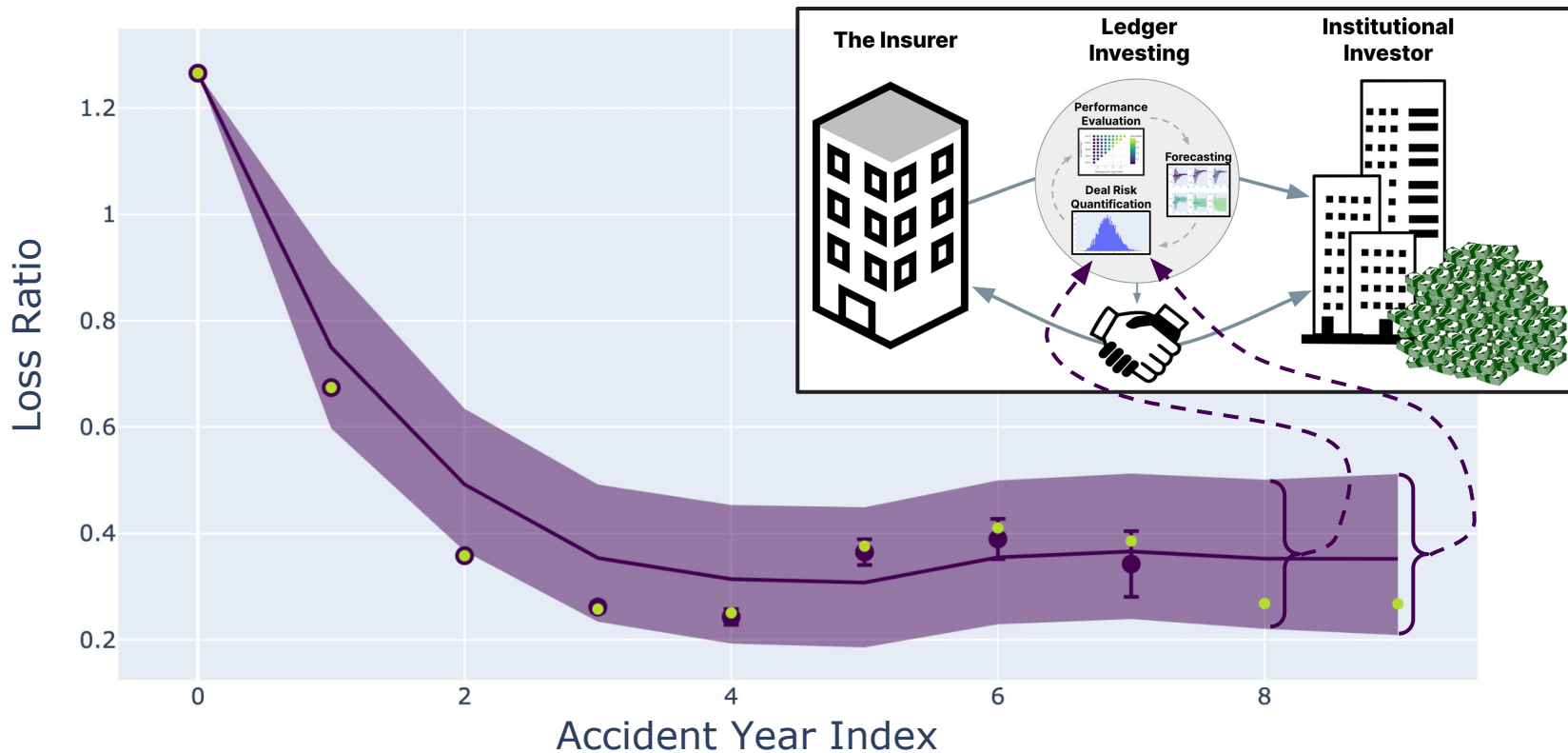
Ledger's Bayesian workflow to measure and forecast insurance risk

Actual Future Loss Ratios vs Forecasted Posterior Predictions



Ledger's Bayesian workflow to measure and forecast insurance risk

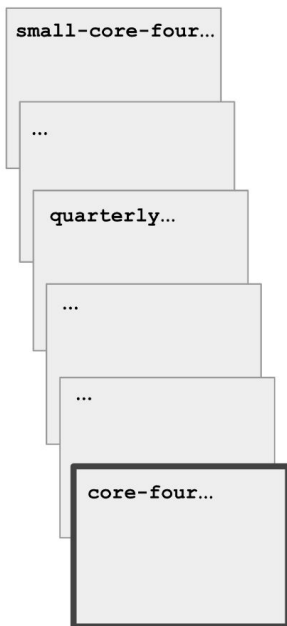
Actual Future Loss Ratios vs Forecasted Posterior Predictions



Ledger's Bayesian workflow to measure and forecast insurance risk

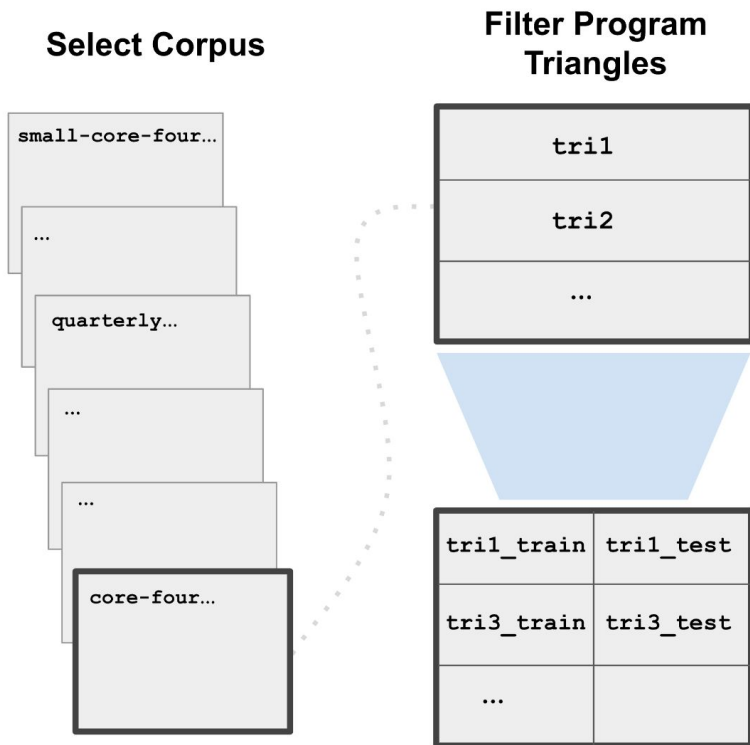
How do we determine which models to use?

Select Corpus



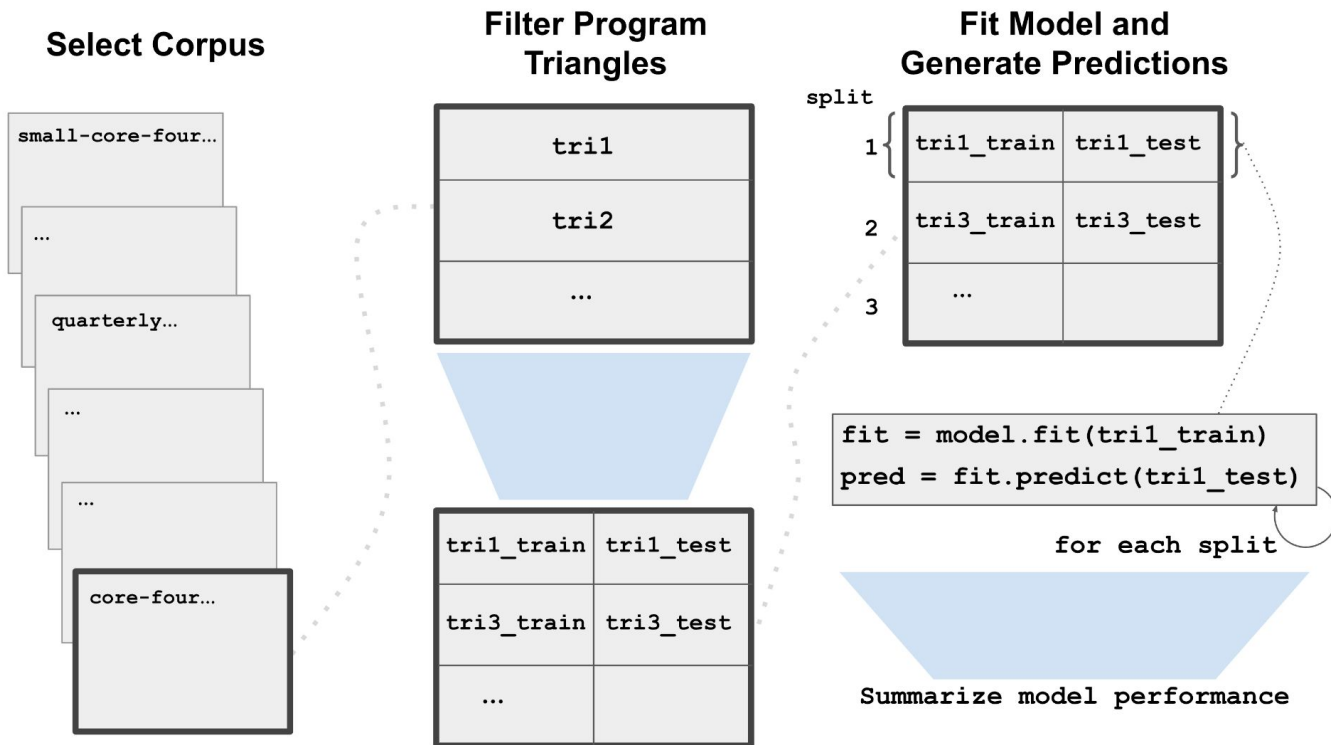
Ledger's Bayesian workflow to measure and forecast insurance risk

How do we determine which models to use?



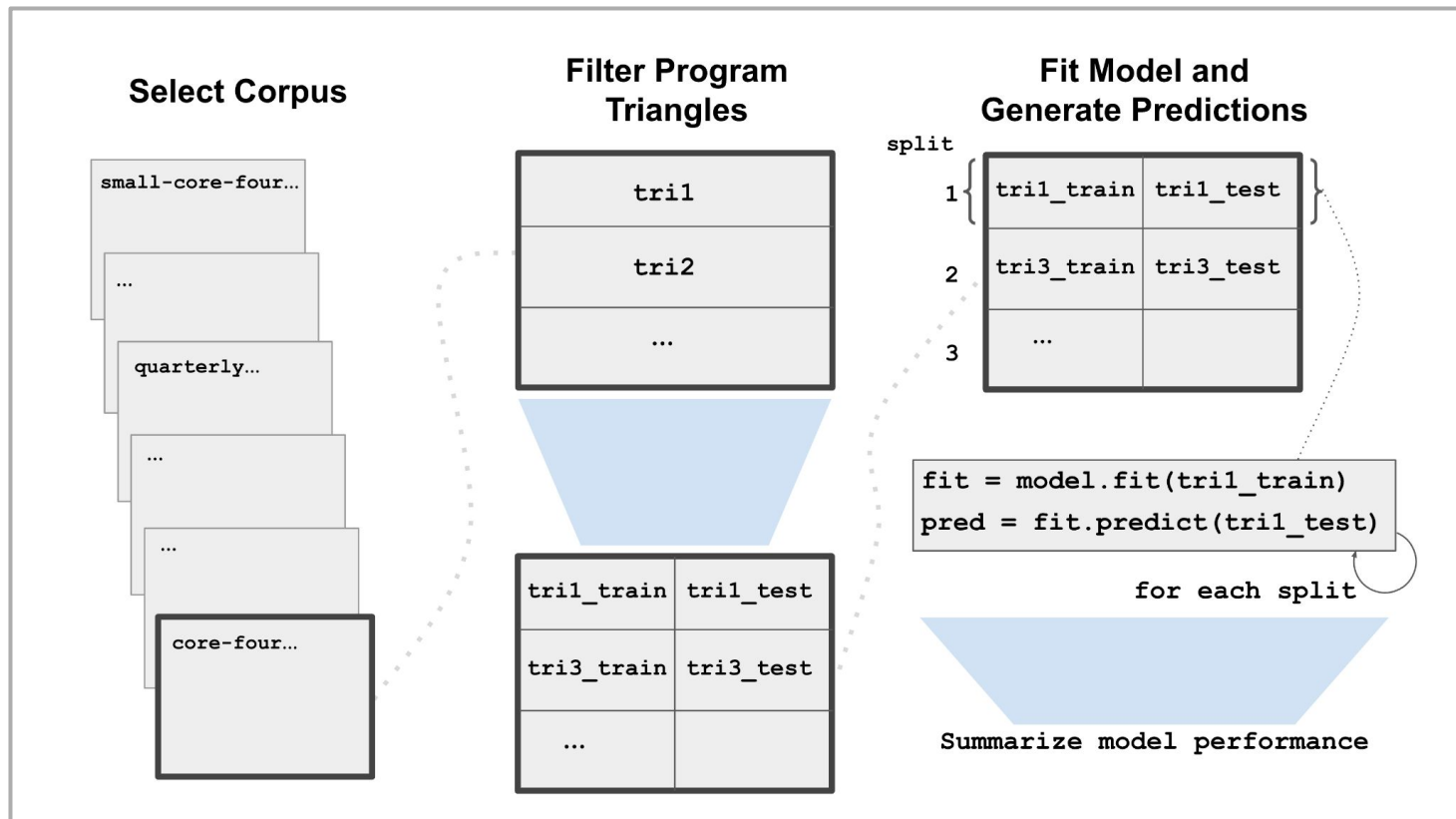
Ledger's Bayesian workflow to measure and forecast insurance risk

How do we determine which models to use?

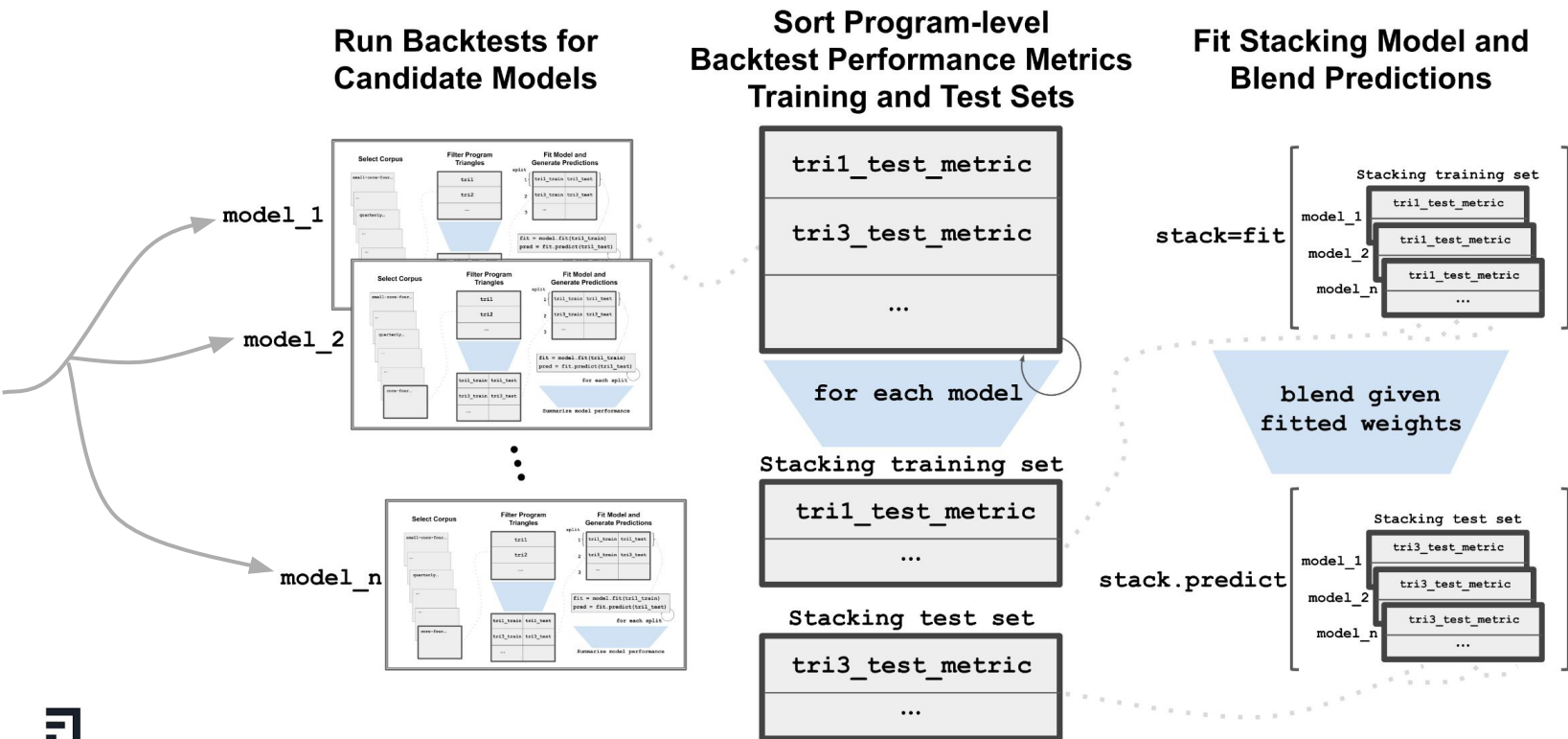


Ledger's Bayesian workflow to measure and forecast insurance risk

How do we determine which models to use?



How do we determine which models to use?



Thanks!

DISCLAIMER

The risk and return performance metrics shown are based on: (i) historical data based on insurance company statutory filings for major casualty product lines that has not been verified by Ledger, (ii) current insurance and reinsurance pricing, and (iii) financial structures that include some element of profit/loss sharing with originators and limits on liability. While Ledger believes that the performance metrics shown are representative of the investment strategy and financial structures that Ledger will use to manage its fund, in the future, the investment strategy and methodology will continually develop and may be modified. Future investments may be made in possibly different portfolios of insurance policies that reflect future insurance market and economic conditions and whose performance may be materially different.

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