Correcting Reporting Delays in Cyber Events at Industry Level

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Outline

- Business Problem
- Solution in Development
- Key Take-aways

Business Problem

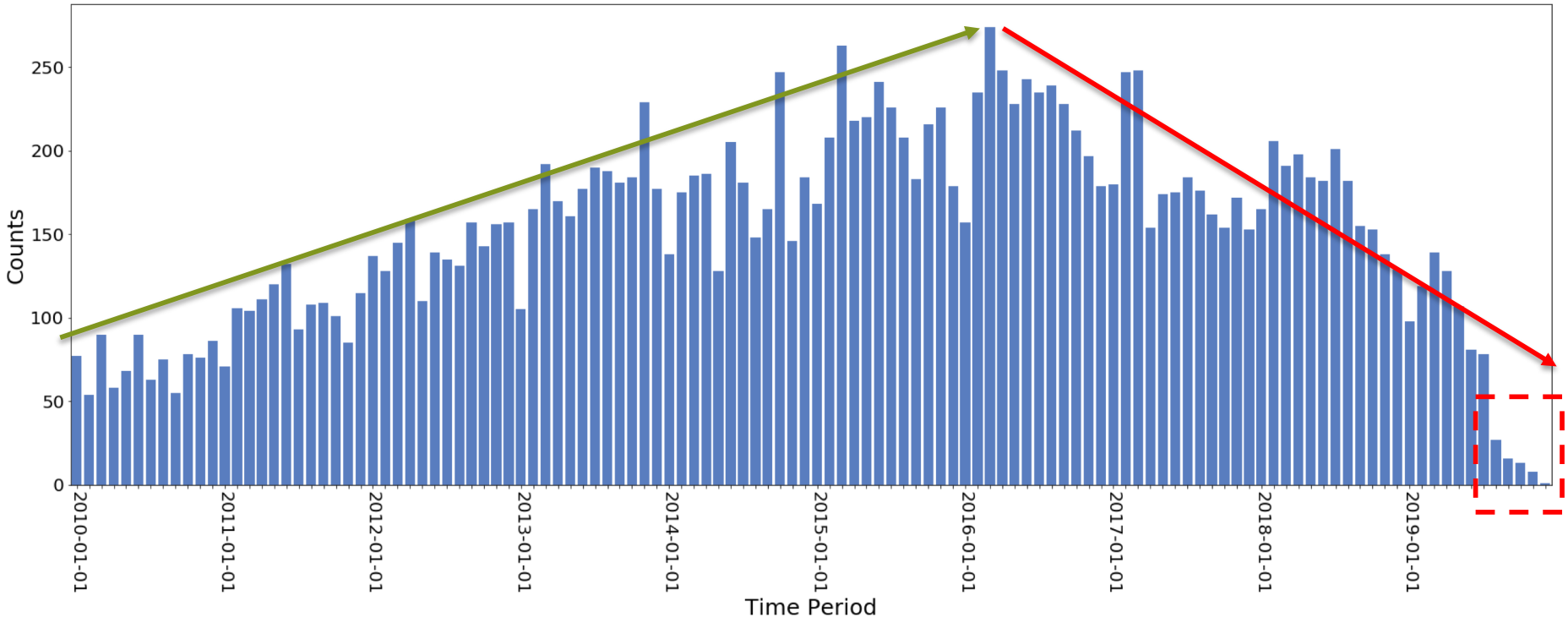
- Reporting Delays: Takes up to 10 years for the event to be entered into the database
- Cyber Models with such incomplete information would be questionable
- Business Problem: To correct for the false diminishing trend in counts due to reporting delays

Business Problem: Data

AIR Worldwide Proprietary data

When?		Where?	Who?
Incident Date	Reporting Date	Country	Industry

Business Problem : Monthly Cyber Event Counts (reported) US Finance and Insurance Industry



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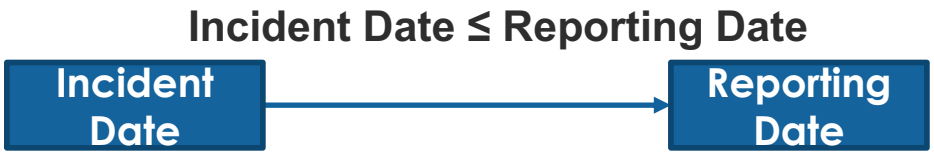
Solution in Development: Delay and Age

- Delay:



- Age :

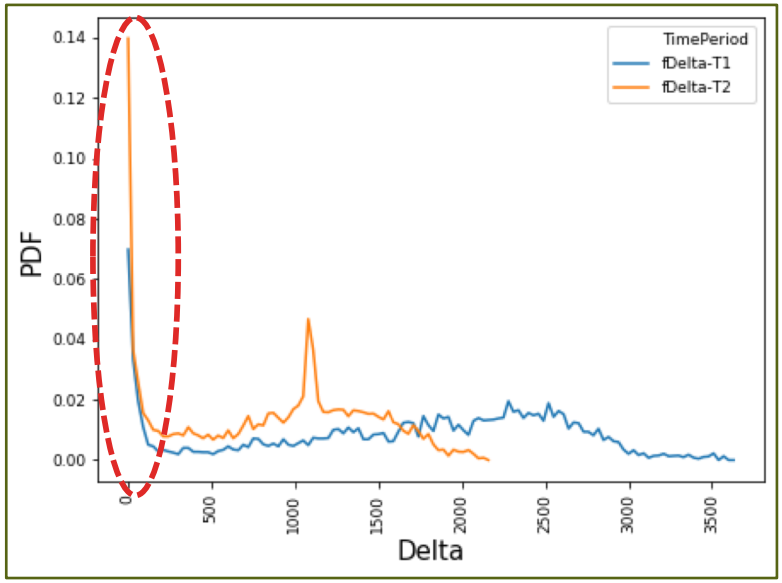
Solution in Development: Delay Distribution

Delay Distribution generated based on Delay Ratio

$$\frac{\#Events\ with\ delay}{Estimated\ True\ \#Events\ where\ age \geq delay}$$

Solution Development: Problem with distribution generated from Delay ratio

- Non-stationarity observed
- Delay Distribution does not estimate beyond maximum Delay



Modeled distribution is a mixture of an Exponential and a Normal distribution

$$CDF\ at\ \delta, F_\theta = \alpha\left(F_{Exp}(\delta, 0, Scale)\right) + (1-\alpha)\left(F_N(\delta, \mu, \sigma)\right)$$

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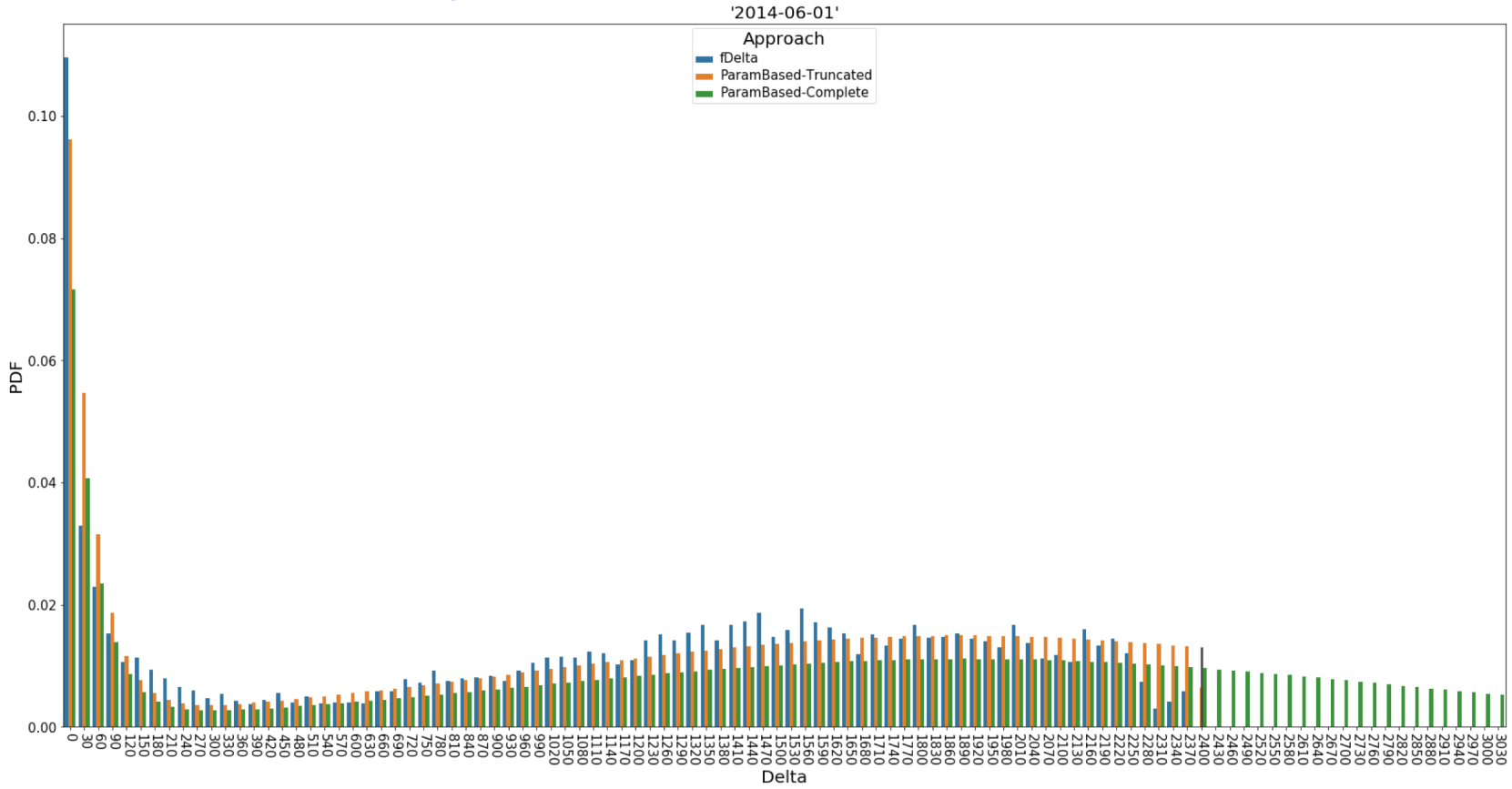
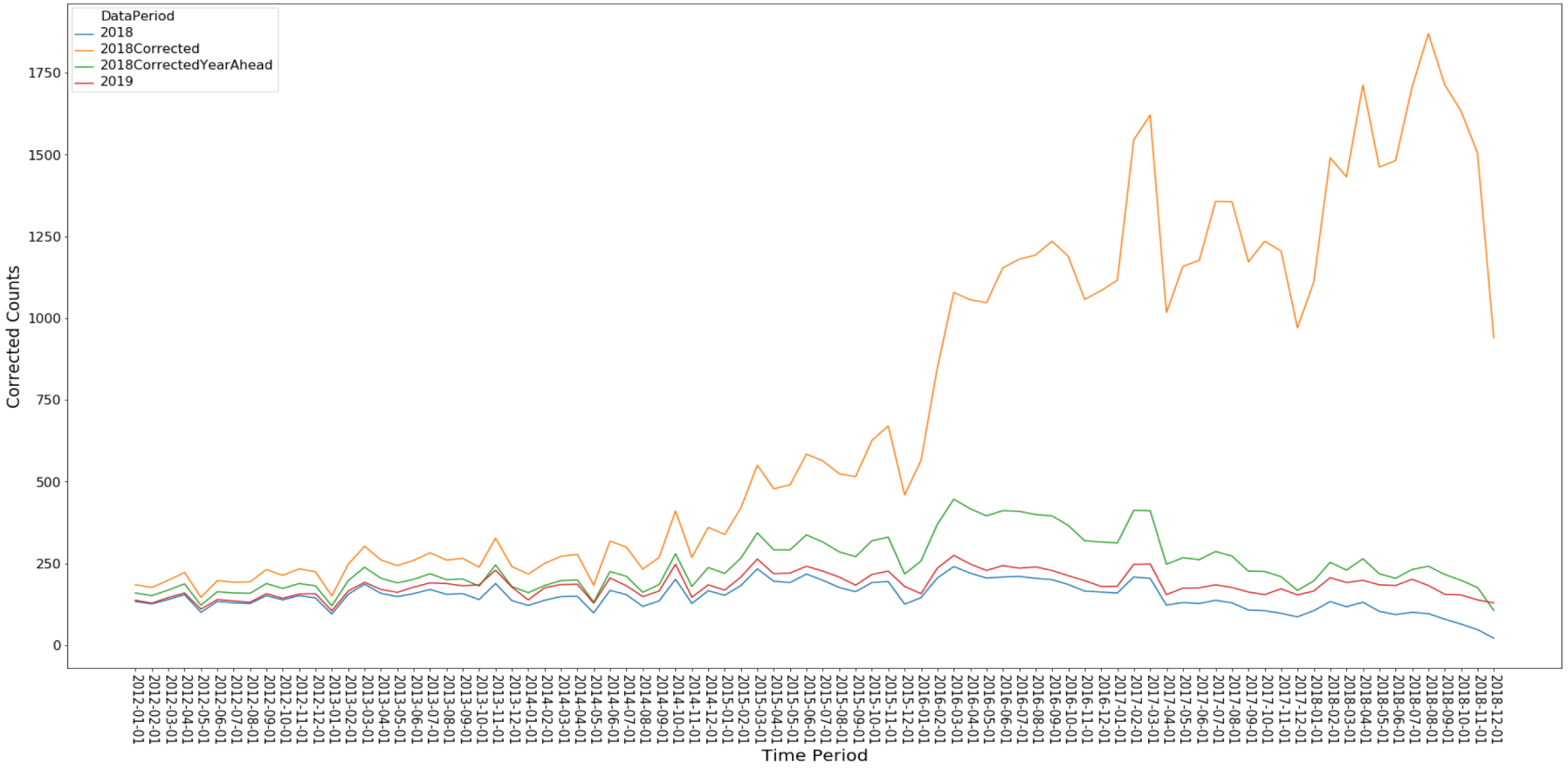
Solution in Development: Function Performance



Solution in Development: Validation Plot



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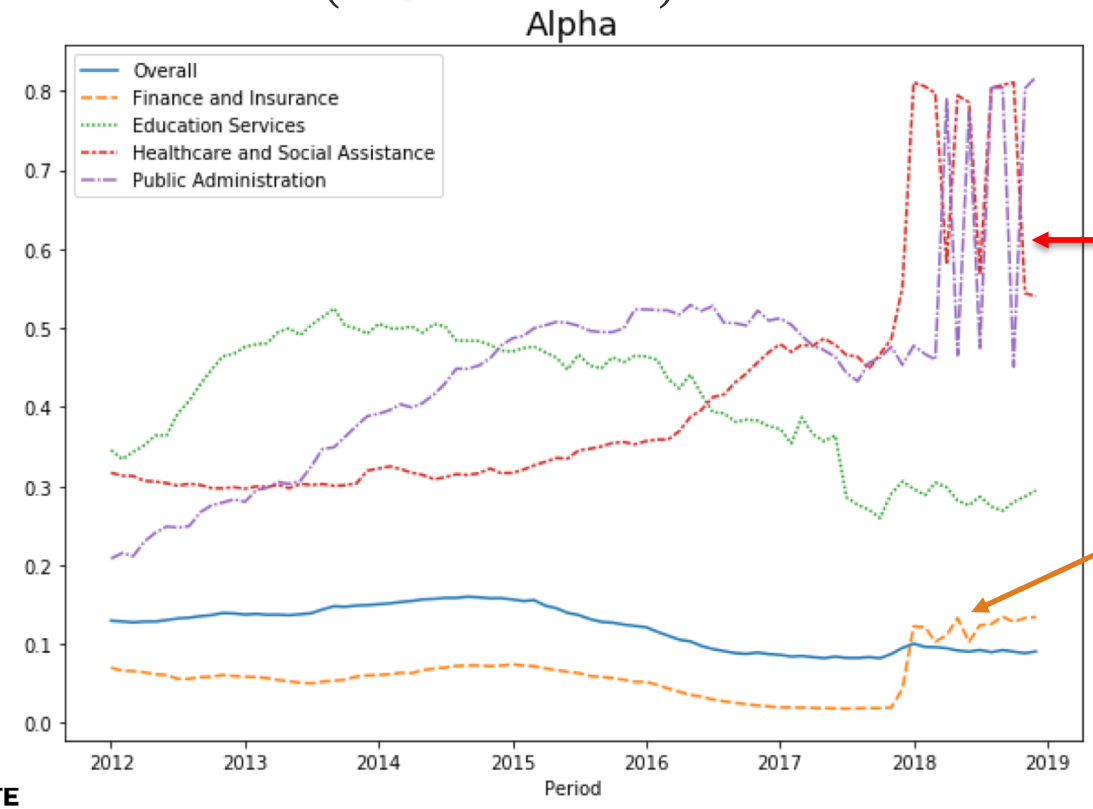
Key Take-away: Alpha - Comparison at Industry level

$$CDF\ at\ \delta, F_\theta = \boldsymbol{\alpha}\left(F_{Exp}(\delta, 0, Scale)\right) + (1 - \boldsymbol{\alpha})\left(F_N(\delta, \mu, \sigma)\right)$$



Gets detected at shorter delays

Not being detected at shorter delays

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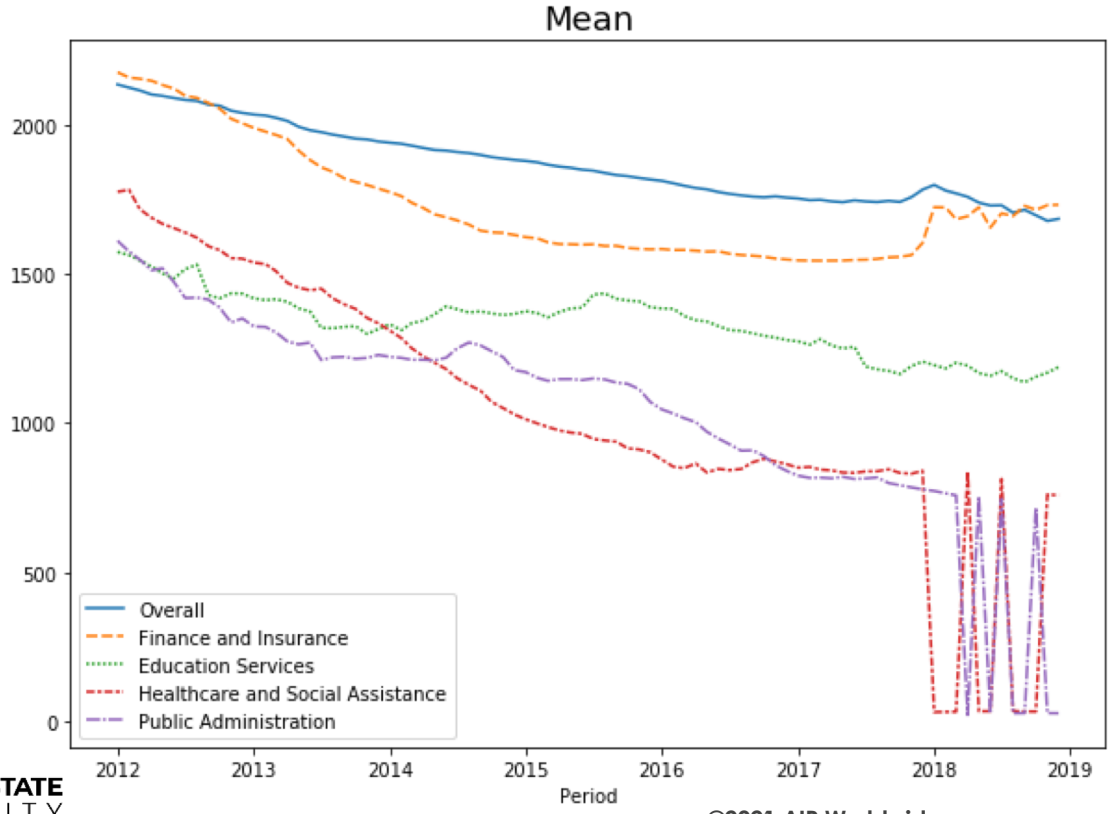
Key Take-away: Mean - Comparison at Industry level

$$CDF\ at\ \delta, F_\theta = \alpha\left(F_{Exp}(\delta, 0, Scale)\right) + (1-\alpha)\left(F_N(\delta, \boldsymbol{\mu}, \sigma)\right)$$



Key Take-away

In order to obtain credible cyber model

- Despite most recent cyber database, data requires debiasing
  - Reporting delays need to be addressed
- Each industry has its own modeled delay distribution
  - Different industries had large differences
- Better decision made with better data

Questions

Solution in Development: Optimization Function

Optimization Function

1. Compares empirical Delay Distribution with Modeled Delay Distribution up to maximum delay
2. Compares Modeled Delay Distribution beyond maximum delay for two consecutive months
3. Penalizes negative delays

$$CDF\ at\ \delta, F_\theta = \alpha\left(F_{Exp}(\delta, 0, Scale)\right) + (1-\alpha)\left(F_N(\delta, \mu, \sigma)\right)$$

$$\theta = (\alpha, Scale, \mu, \sigma)$$

$$\boldsymbol{\theta_{Opt}} = \underset{\theta=(a,Scale,\mu,\sigma)}{\operatorname{argmin}} \underbrace{\frac{1}{n}\|\log_{10} F_\theta - \log_{10} F_\Delta\|^2}_{Truncated\ until\ \delta_{max}} + \underbrace{(F'_{\theta'} - F'_\theta)^2}_{Beyond\ \delta_{max}} + \underbrace{F_N^2(0, \mu, \sigma)}_{Below\ \delta=0}$$

$$F_\Delta = Monthly\ Delay\ Distribution\ rolling\ over\ 2-year\ window$$

$$F_\theta = F_\theta\ defined\ over\ (0, \infty)$$

Thanks