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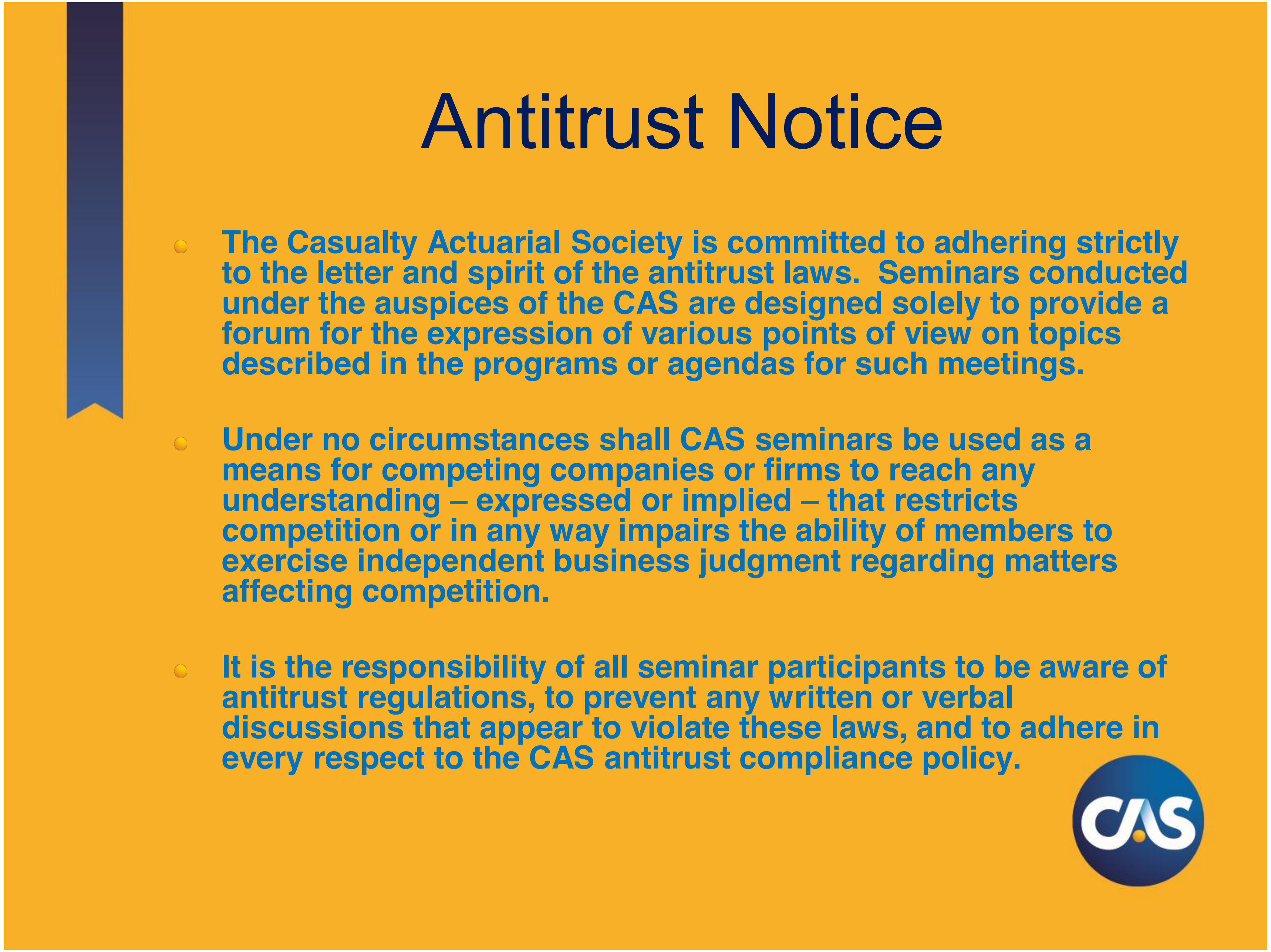
# Model Data Breach Risk under Catastrophe Model Framework

November 2019



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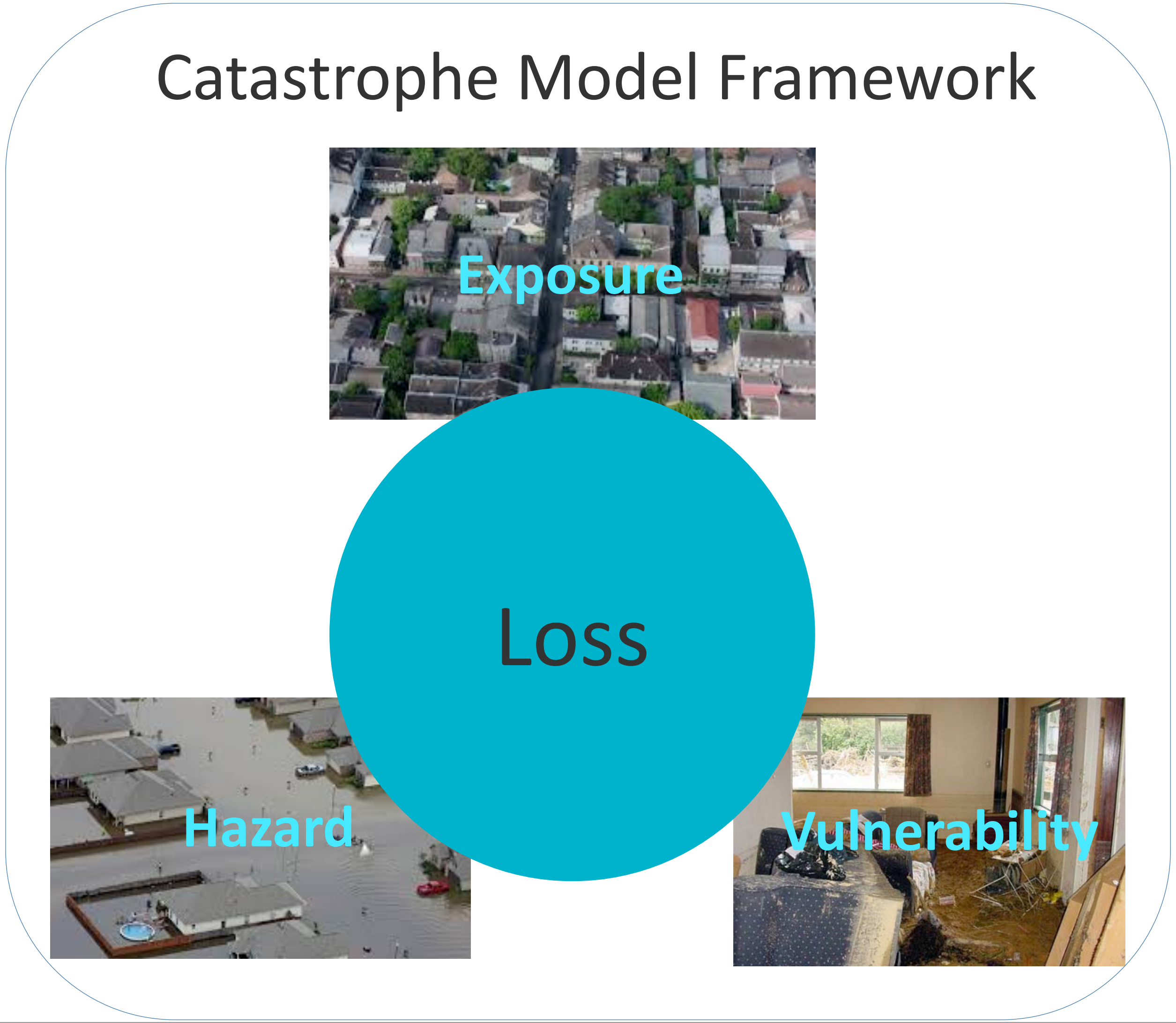
# Data Breach Risk Overview

- Data breach (DB) incident
  - unintentional disclosure of sensitive data from organizations, lead to identity and IP theft, financial fraud, and cyber extortion
- "One massive hack after another"
- Severe consequences for consumers and organizations:
  - direct loss: investigation, notification of victims, credit monitoring, regulatory fines, etc.
  - indirect loss: revenue losses from business disruption, customer turnover, reputational damage

- 2018 Cyber Claims Study (by NetDiligence):
  - total cost ranged from $110 to $80M for 1201 cyber claims in 2013-2017 (companies <$2B in revenue)
- 2019 Cost of a Data Breach Report (by Ponemon Institute):
  - the average total cost of a data breach in the U.S. has grown from $3.5 M in 2006 to $8.2 M in 2019

# Use NAT-CAT Model Framework

- CAT DB event, a man-made CAT event
    - "technological equivalent of extreme weather"
- Heavy tailed distribution of data breach is similar to those of the extreme NAT CAT events.



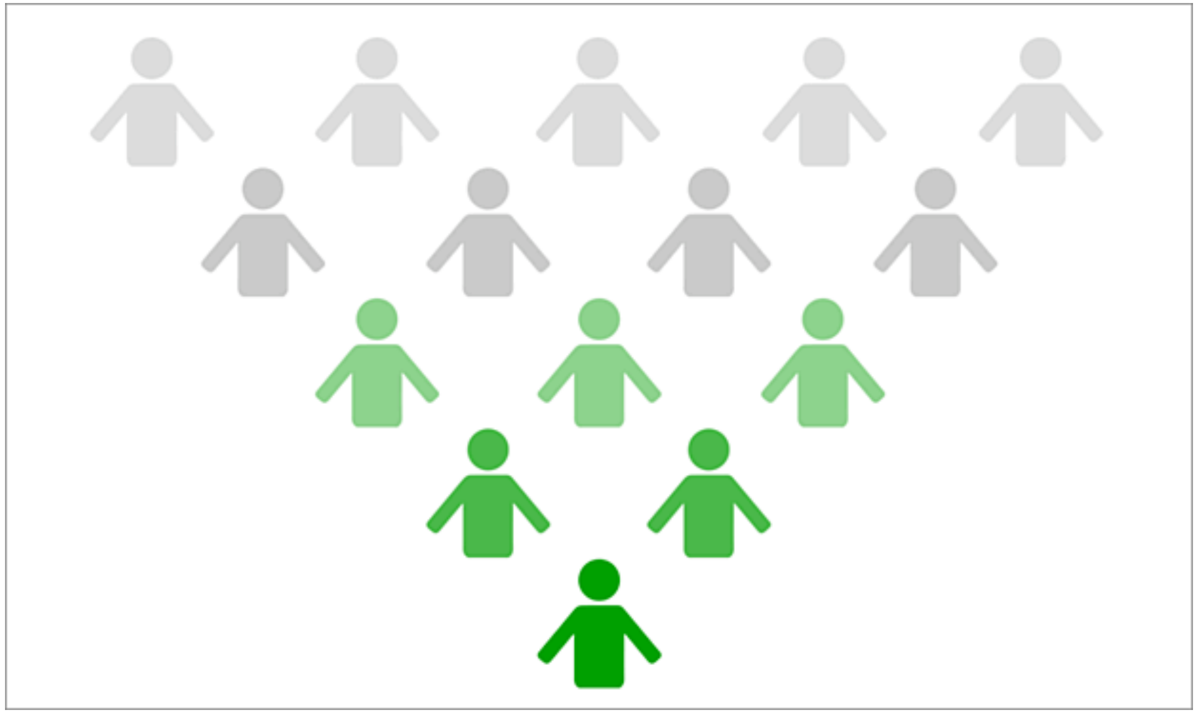
# Data Breach Risk Modeling in CAT Framework

- Exposure: quantity, type, and value of record at risk
- Hazard: threat that may lead to a data breach event
  - Frequency: learned from historical incidents
  - Attackers: internal, external, or more sophisticated actors such as hacktivists
- Vulnerability: damage ratio to total record
- Damage: affected record count
- Loss: cost of an event

Catastrophe Model Framework

Exposure
Loss
Hazard
Vulnerability

# Exposure: total record count = employee + user count



*Utilities*

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Uber

facebook

*Hospitality*

priceline

MARRIOTT

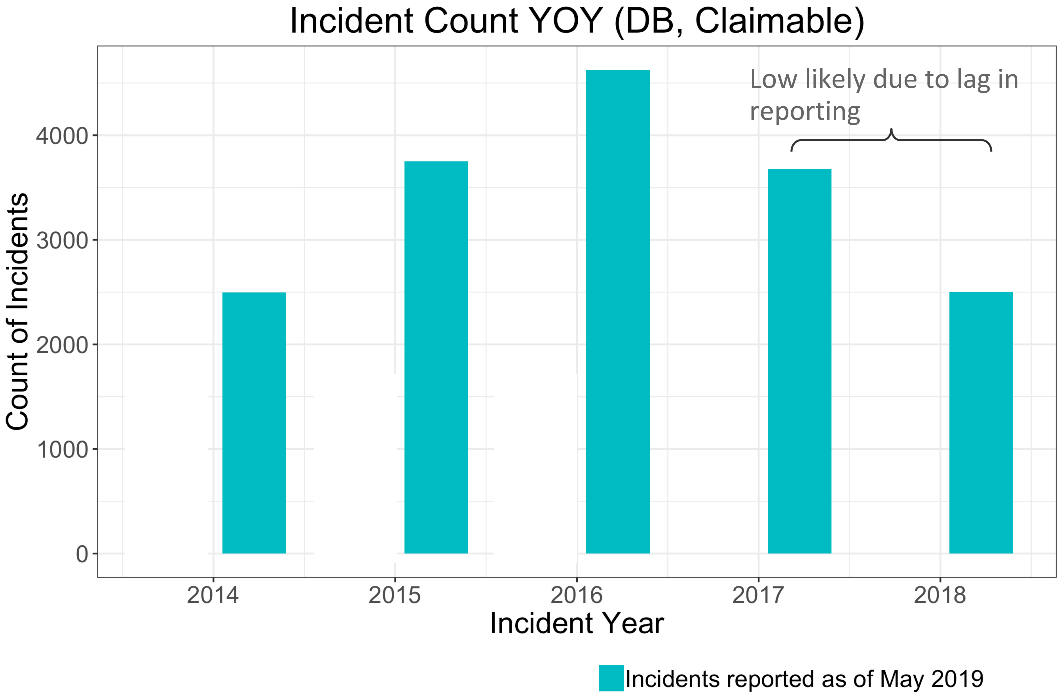
*Financial services*

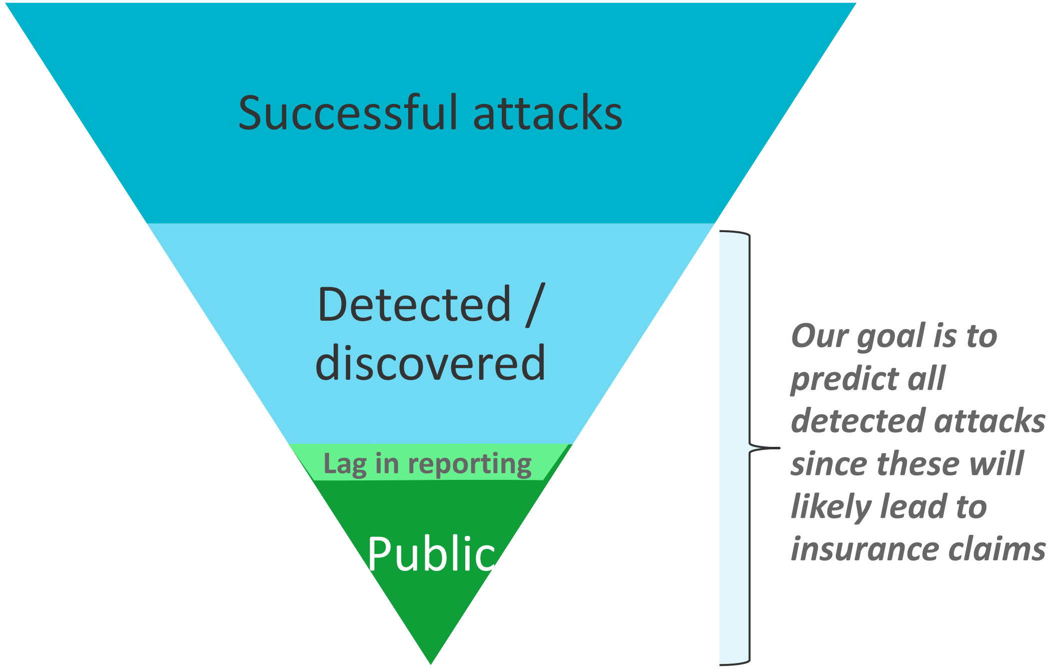
J.P.Morgan

Anthem.

# Hazard: events that lead to data breach

- **Event Frequency:**
  - Evolving landscape
  - Lag in reporting
  - Zero-inflated model is applied

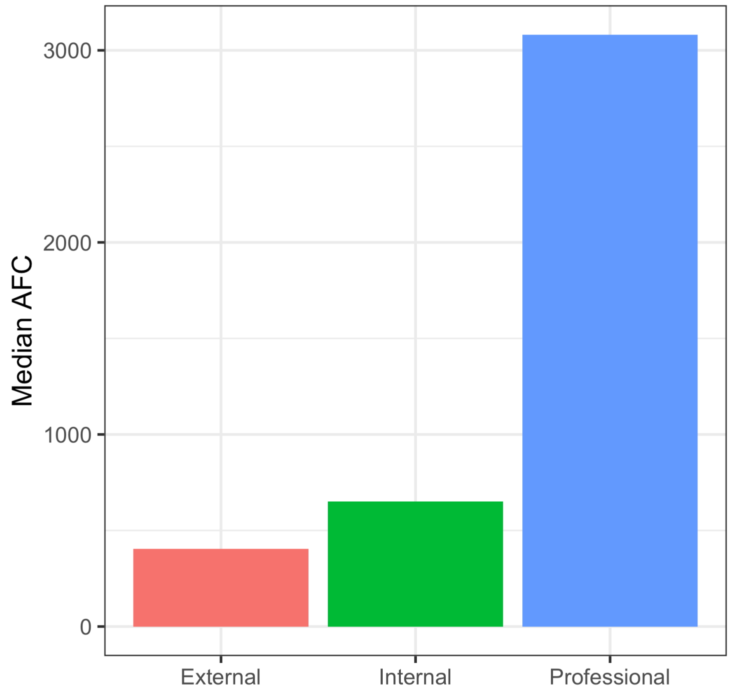




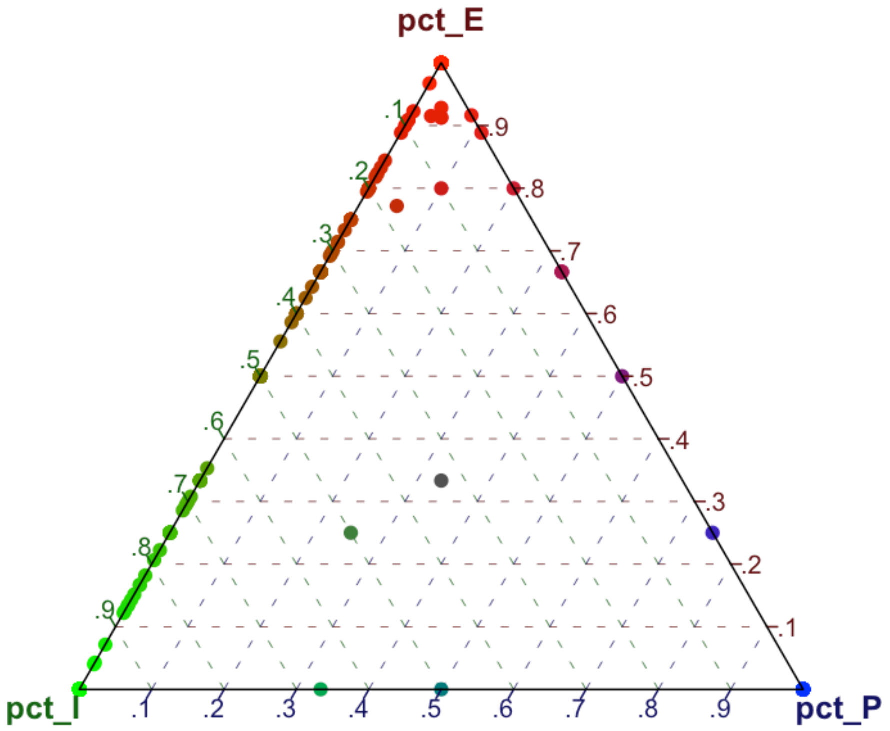
*Our goal is to predict all detected attacks since these will likely lead to insurance claims*

# Hazard: events that lead to data breach

- **Attackers**
  - **Professional**: hacktivist, terrorist, and criminal organization
  - **External**: former employee, former consultant, vendor, etc.
  - **Internal**: employee, consultant, trusted third party, organization, etc.



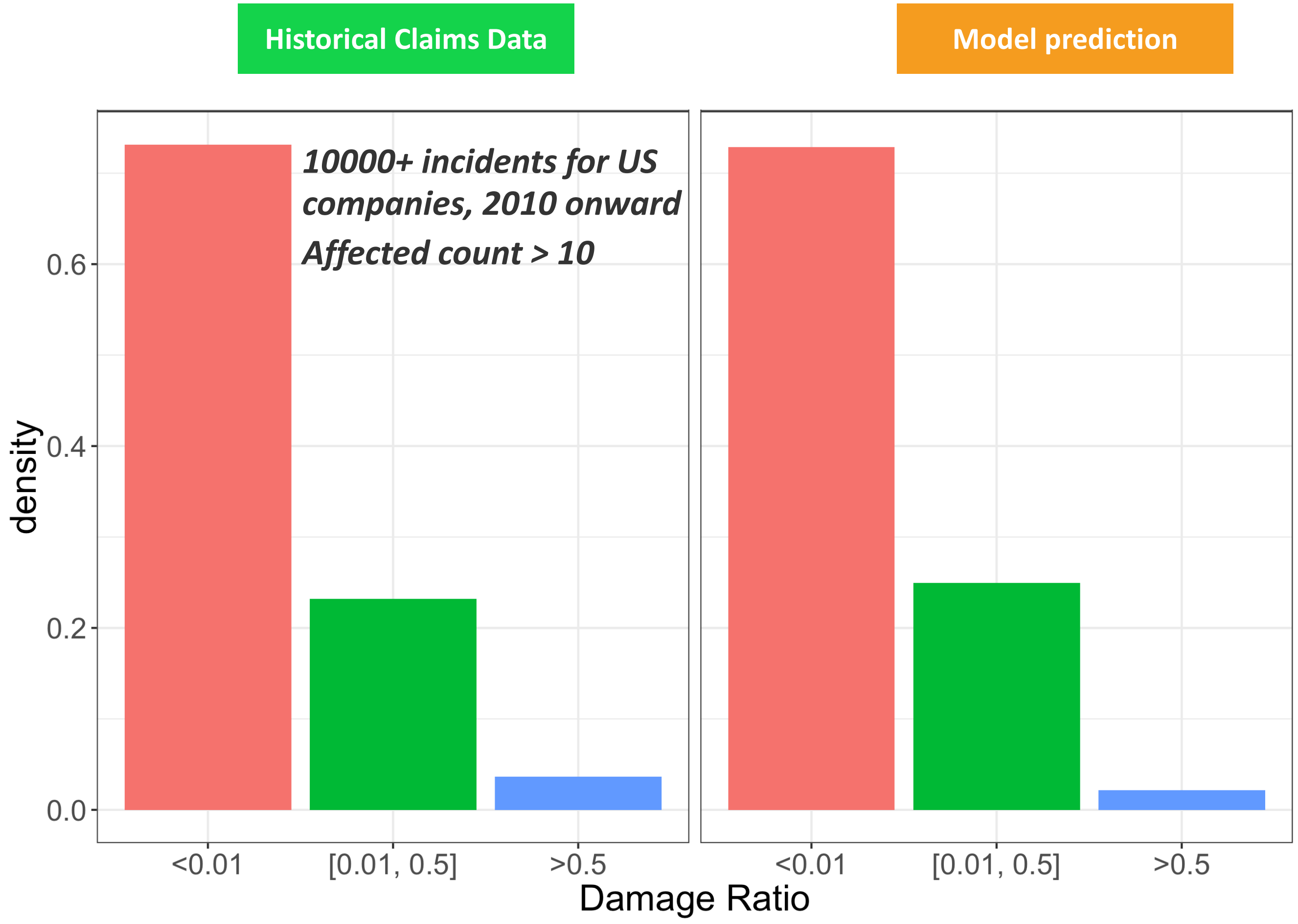
- **A predictive model for the probability of attacker type**
  - Attributes include …



**probability of a company being attacked among the three attacker types (historical incidents for companies)**

# Vulnerability: damage ratio to exposure

- Damage ratio (DR) definition
- Analysis of historical incidents reveals ...
- How to model DR

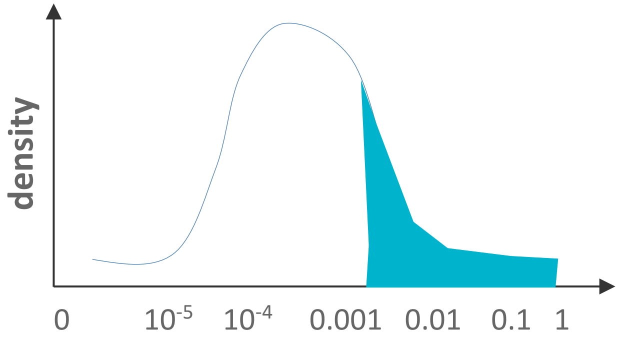


***10000+ incidents for US companies, 2010 onward***

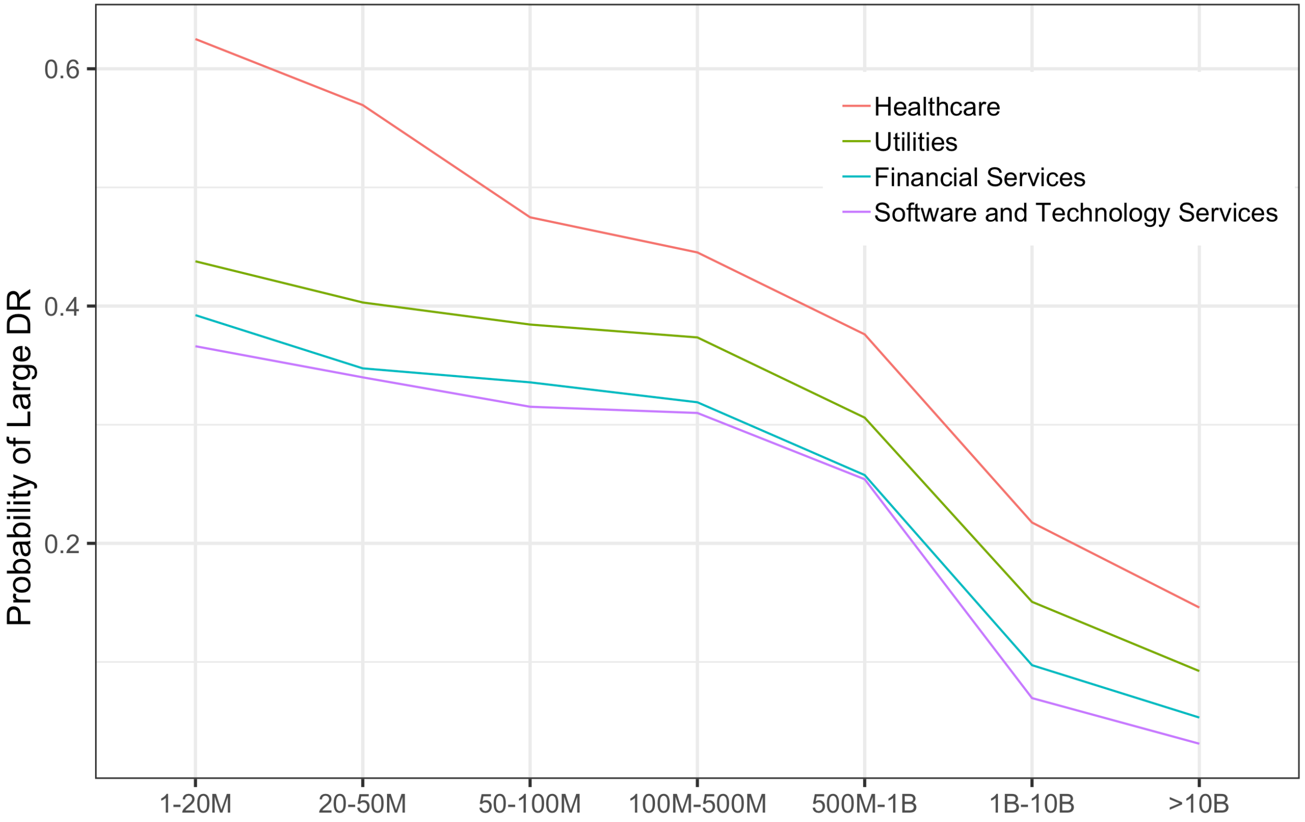
***Affected count > 10***

# Vulnerability: damage ratio to exposure

- Probability of large DR

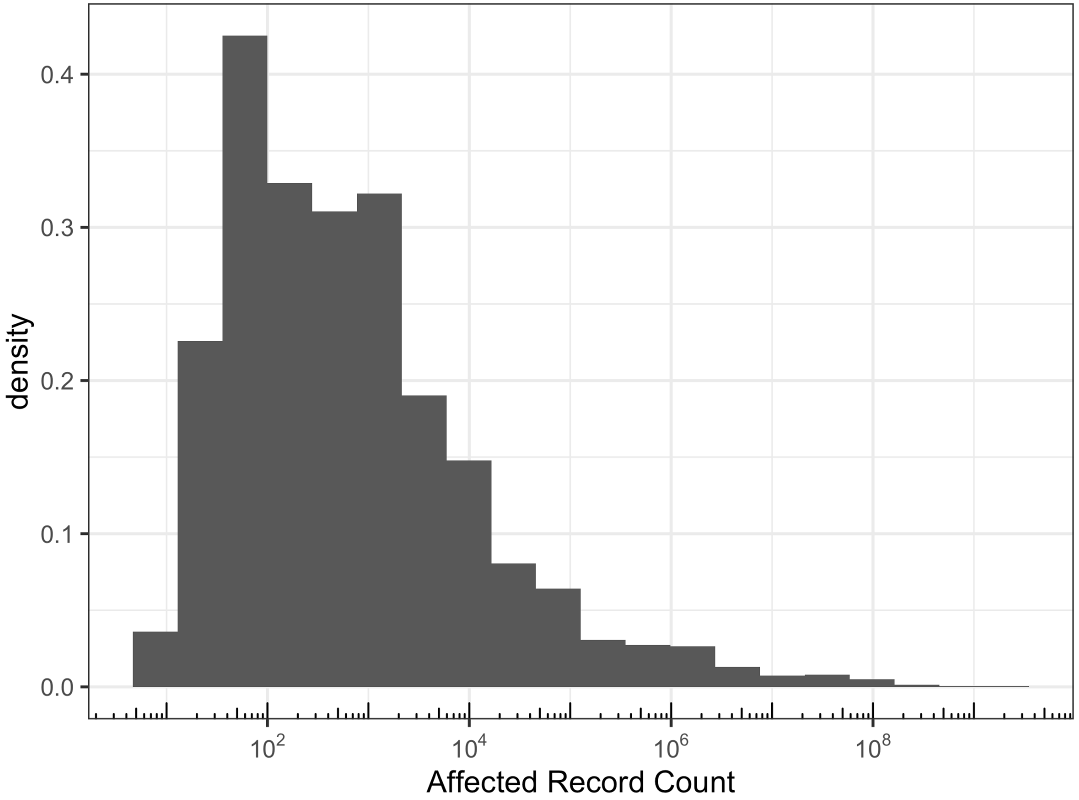


- Variation among industry sectors
- Variation among revenue bins
  - Smaller companies are more likely to have less preventative measures and therefore data is less distributed
  - Larger companies segment network and data and therefore have a lower likelihood of losing a large number of records



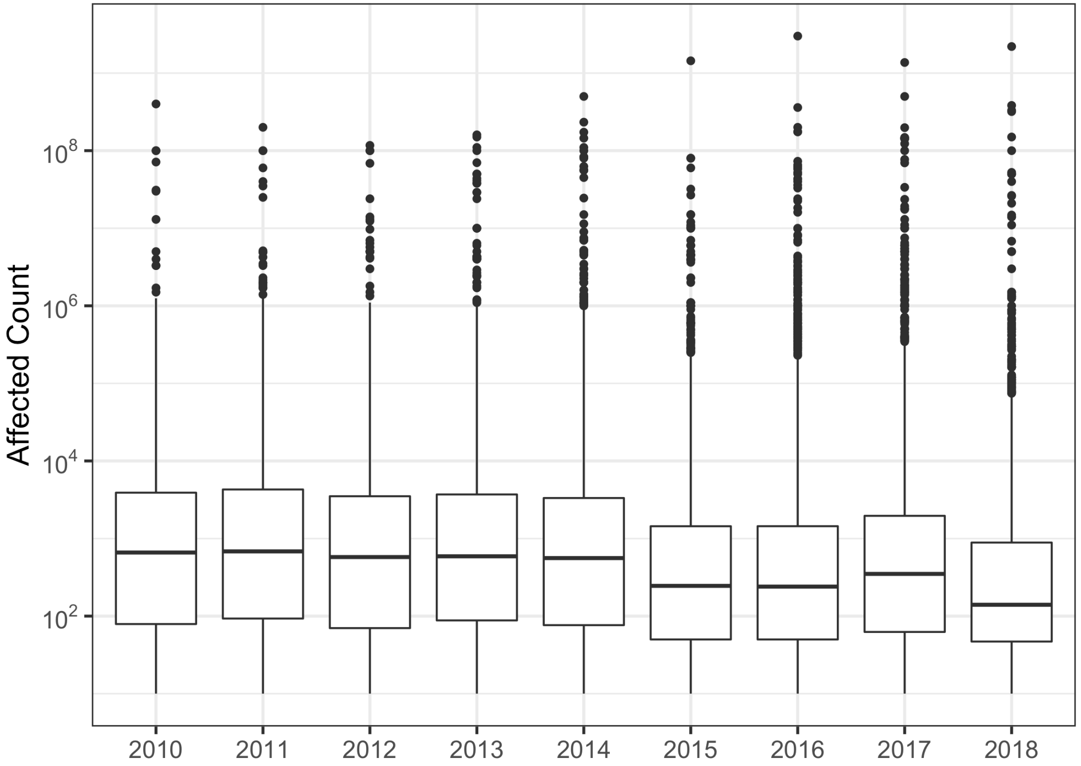
# Damage:
# affected record count = total record count x damage ratio

- Historical data of data breach size



**Histogram of AFC for data breach incidents occurring to US companies in 2009-2018 with AFC > 10**

- Size of data breach is not really increasing over the past decade



**Yearly change of AFC for data breach incidents occurring to US companies in 2009-2018 with AFC > 10**

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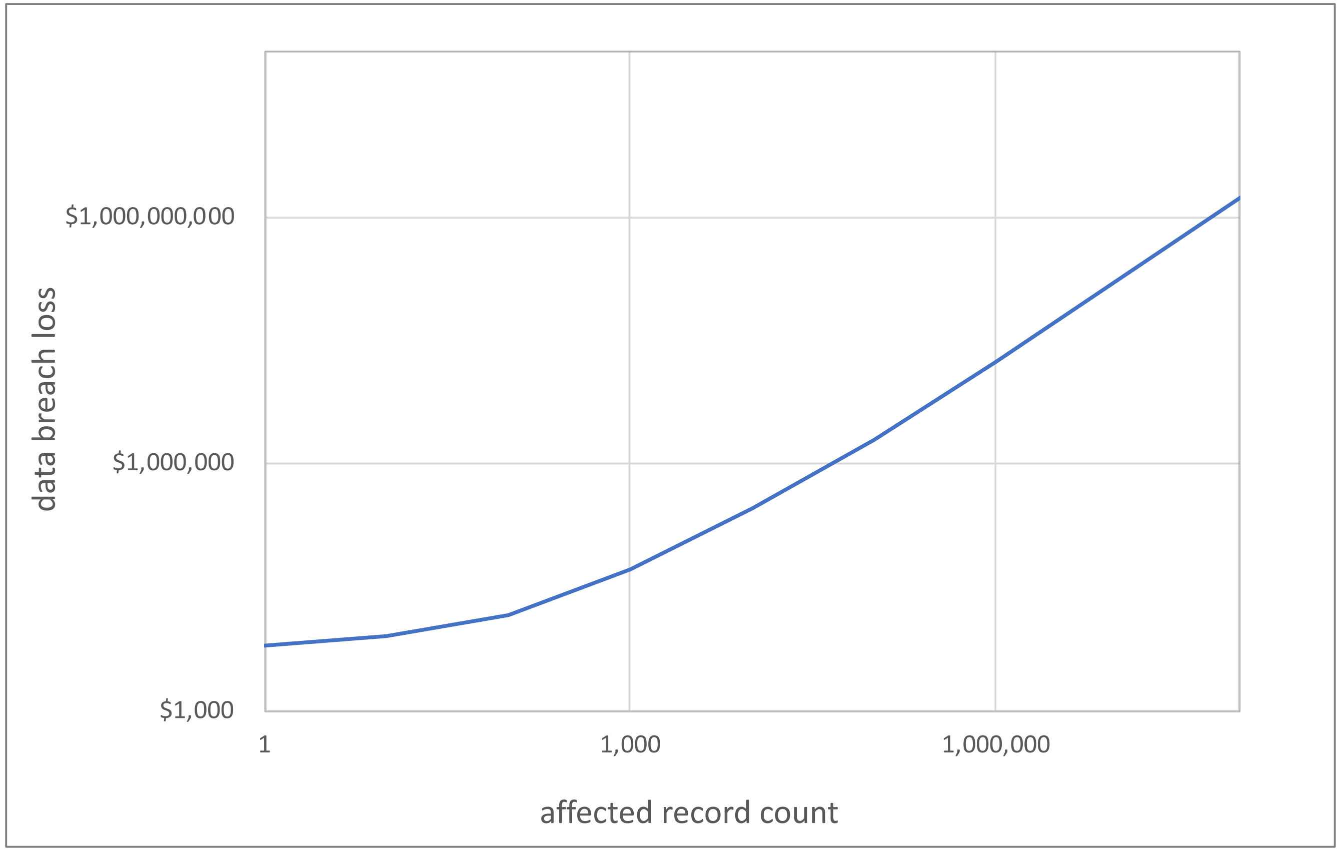
# Loss estimation

- **Loss**
  - investigation costs,
  - notification and post event response costs,
  - regulatory fines and penalties
- **Loss varies with**
  - affected record count
  - type of record (PCI, PHI, PII)
  - country or region
  - data breach history (first time breach ?)



**Example: the relationship between data breach cost and affected record count for PCI data type**

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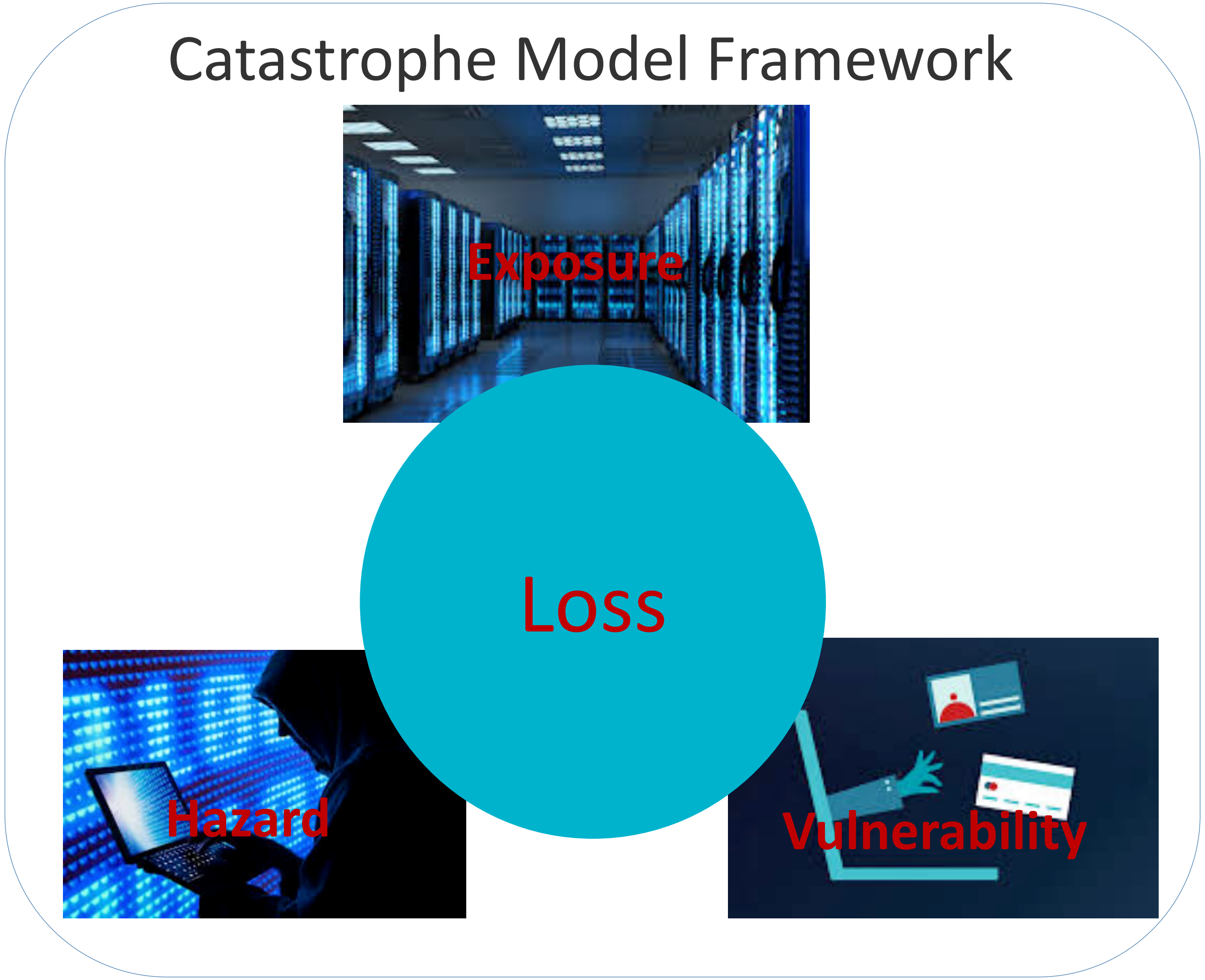
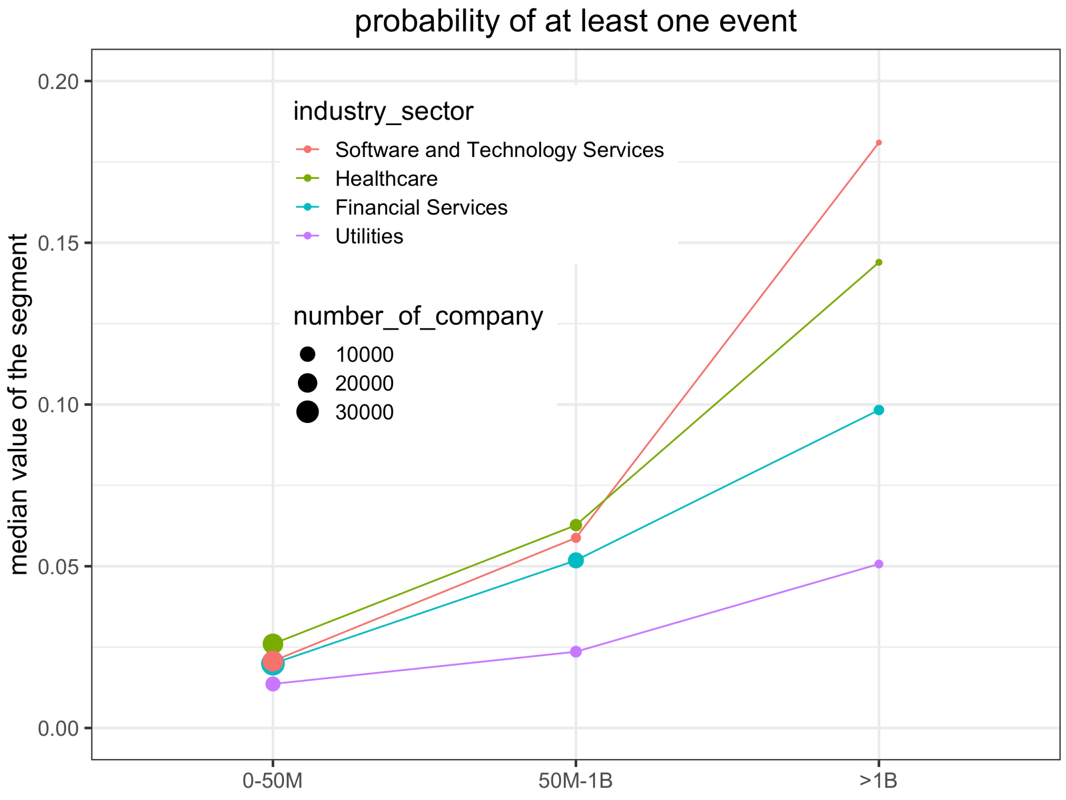
Catastrophe Model Framework



# Model Implication

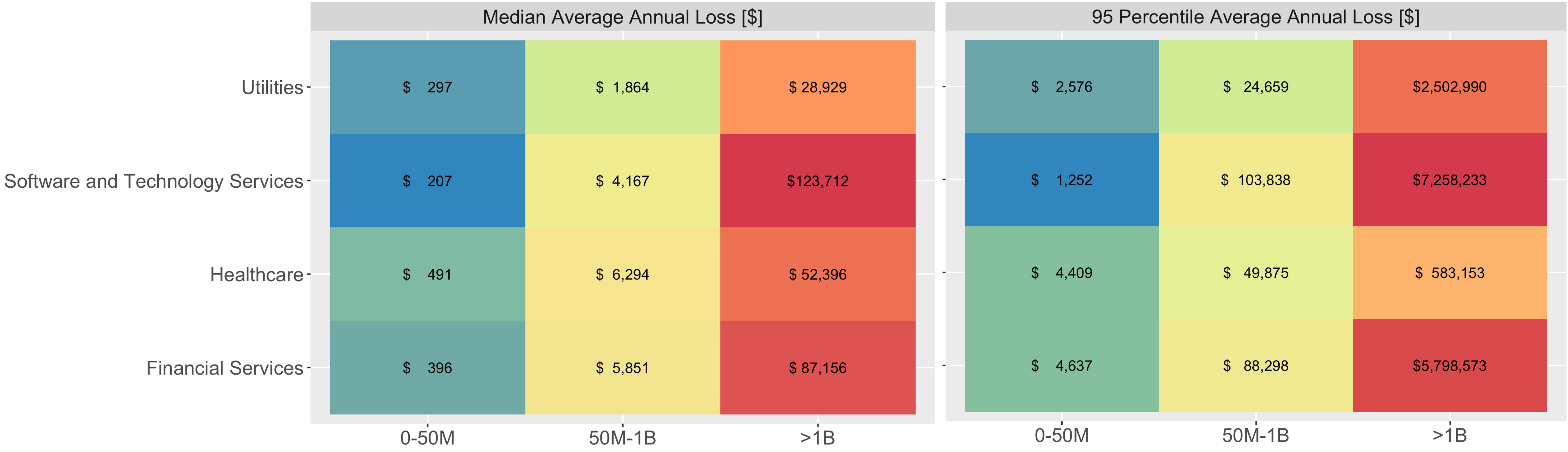
- Predict the likelihood of breaches of a particular size in the coming year, e.g. when a company loses a certain proportion of its total record



Median value of each segment (selected sectors)

# Model Implication

- Provide views of financial loss due to data breach events on both an event-by-event and annual basis



Median Average Annual Loss [$]

| | 0-50M | 50M-1B | >1B |
|---|---|---|---|
| Utilities | $ 297 | $ 1,864 | $ 28,929 |
| Software and Technology Services | $ 207 | $ 4,167 | $123,712 |
| Healthcare | $ 491 | $ 6,294 | $ 52,396 |
| Financial Services | $ 396 | $ 5,851 | $ 87,156 |

95 Percentile Average Annual Loss [$]

| | 0-50M | 50M-1B | >1B |
|---|---|---|---|
| Utilities | $ 2,576 | $ 24,659 | $2,502,990 |
| Software and Technology Services | $ 1,252 | $ 103,838 | $7,258,233 |
| Healthcare | $ 4,409 | $ 49,875 | $ 583,153 |
| Financial Services | $ 4,637 | $ 88,298 | $5,798,573 |

**Average annual loss from data breach by segment (selected sectors)**

# THANK YOU

Questions and Answers

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