Model Data Breach Risk under Catastrophe Model Framework

November 2019
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Data Breach Risk Overview

• Data breach (DB) incident
  o 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:
  o direct loss: investigation, notification of victims, credit monitoring, regulatory fines, etc.
  o indirect loss: revenue losses from business disruption, customer turnover, reputational damage

• 2018 Cyber Claims Study (by NetDiligence):
  o 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):
  o 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
Exposure: total record count = employee + user count
**Hazard: events that lead to data breach**

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

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**Incident Count YOY (DB, Claimable)**

<table>
<thead>
<tr>
<th>Incident Year</th>
<th>Count of Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>2000</td>
</tr>
<tr>
<td>2015</td>
<td>3000</td>
</tr>
<tr>
<td>2016</td>
<td>4000</td>
</tr>
<tr>
<td>2017</td>
<td>3000</td>
</tr>
<tr>
<td>2018</td>
<td>2000</td>
</tr>
</tbody>
</table>

- Low likely due to lag in reporting

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**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 ...

![Bar chart showing Median AFC for External, Internal, and Professional attackers.](chart.png)

![Triangle diagram showing probability of a company being attacked among the three attacker types.](triangle.png)
Vulnerability: damage ratio to exposure

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

• Probability of large DR

• Variation among industry sectors

• Variation among revenue bins
  
  o Smaller companies are more likely to have less preventative measures and therefore data is less distributed
  
  o 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
- Size of data breach is not really increasing over the past decade

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

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

• Loss
  o investigation costs,
  o notification and post event response costs,
  o regulatory fines and penalties

• Loss varies with
  o affected record count
  o type of record (PCI, PHI, PII)
  o country or region
  o 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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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.
Model Implication

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

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

<table>
<thead>
<tr>
<th>Segment</th>
<th>Median Average Annual Loss [$]</th>
<th>95 Percentile Average Annual Loss [$]</th>
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<tbody>
<tr>
<td>Utilities</td>
<td>$297</td>
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<tr>
<td></td>
<td>$1,864</td>
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THANK YOU

Questions and Answers

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