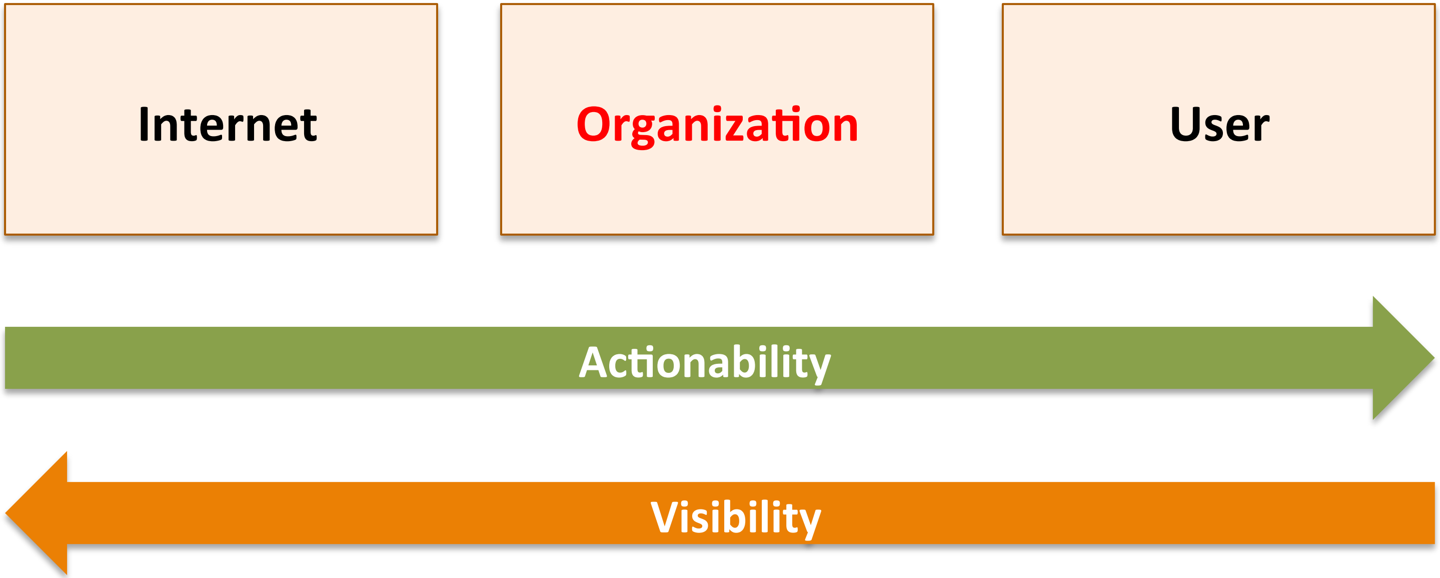
Learning from Early Attempts to Measure Information Security Performance

Jing Zhang[1], Robin Berthier[2], Will Rhee[1], Michael Bailey[1],
Partha Pal[3], Farnam Jahanian[1], and William H. Sanders[2]

[1] University of Michigan
[2] University of Illinois at Urbana-Champaign
[3] BBN Technologies, Cambridge, MA

Importance of Organizations in the Security Ecosystem



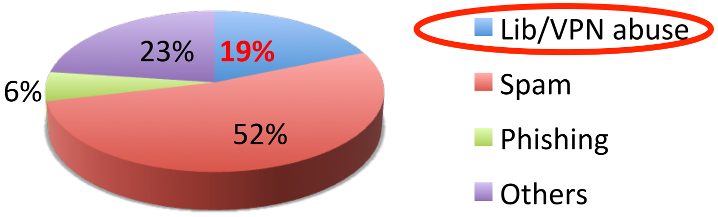
Our Organizations

- Security operation teams at our universities
  - Information and Infrastructure Assurance (IIA) at University of Michigan
  - Security teams at UIUC
- We oversee IT security at the universities
  - More than 40,000 students
  - More than 30,000 faculty and staff at UofM, and more than 10,000 at UIUC
  - Facilitating campus-wide incident response activities
  - Provide services such as security assessment and consultation, network scans, education and training
  - Managing IT security issues at the university level

Organizational Background

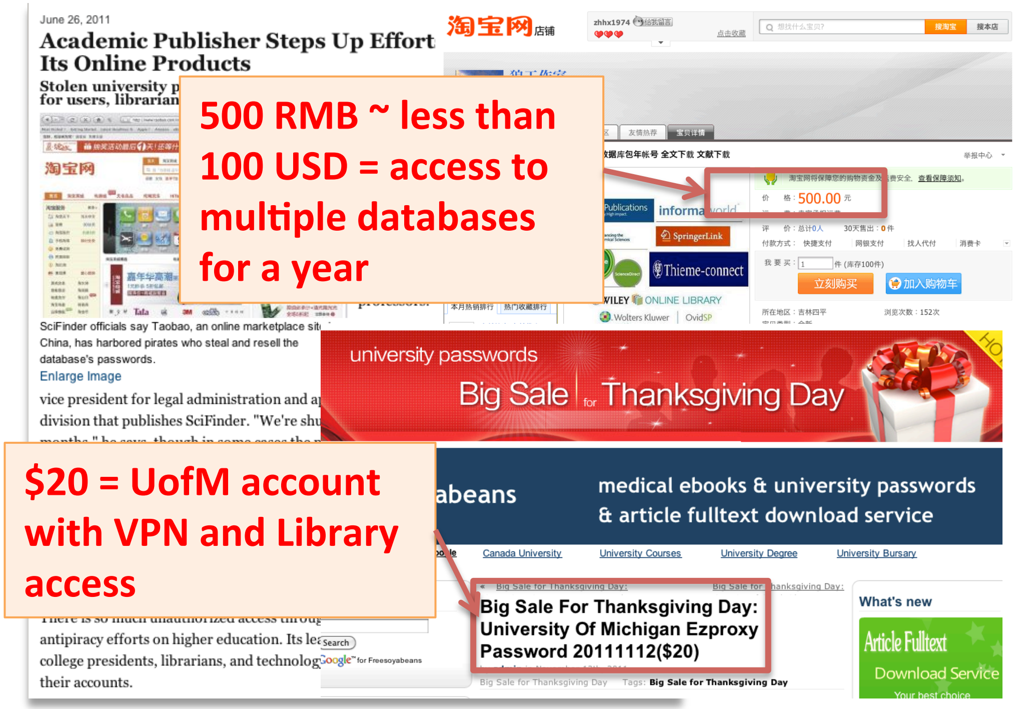
Context: Account compromise at UofM and UIUC

- **613 incidents** related to unauthorized use of university accounts during 2010 and first 6 months of 2011 at UofM



- **178 compromised accounts** were reported in the first half of 2011 at UIUC

- Market place for the compromised university accounts



June 26, 2011

Academic Publisher Steps Up Effort
Its Online Products

Stolen university p
for users, librarian

SciFinder officials say Taobao, an online marketplace sit
China, has harbored pirates who steal and resell the
database's passwords.

Enlarge Image

vice president for legal administration and a
division that publishes SciFinder. "We're shu

There is so much unauthorized access throug
antipiracy efforts on higher education. Its lea
college presidents, librarians, and technolog
their accounts.

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university passwords

Big Sale for Thanksgiving Day

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500 RMB ~ less than 100 USD = access to multiple databases for a year

$20 = UofM account with VPN and Library access

Organizational Goals

- We want to answer:
  - How secure is the organization?
  - Has the secure posture improved over the last years?
  - How to compare with peers with respect to security?
  - What is the marginal change in the security, given the use of a tool or practice?
  - How to prioritize resources to maximize security and minimize risks?
- Security Metrics
  - Micro-level of view
  - Quantified measurement
  - Hard to achieve
    - Complexity of the environment
    - rapid evolution of technology and adversarial action

"We cannot manage what we cannot measure!"

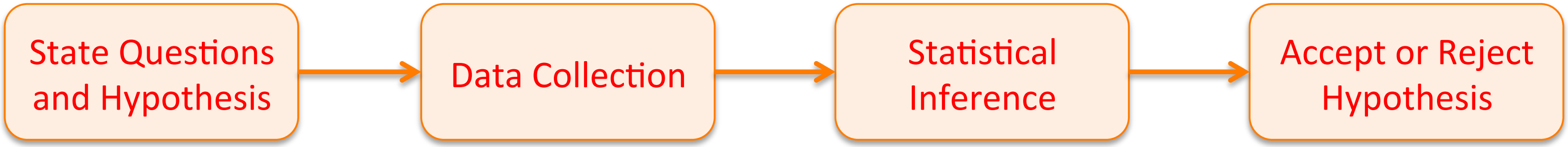
Our Work Today

What we have

- Incidents Tickets
- Authentication Logs
- Victim Information
- Password-cracking results
- Security quiz results

Factors Analyzed

- Victim Demographic
- Temporal Factor
- Geographical Factor
- Topological Factor
- Usage Behavior
- Password Strength
- Security Quiz



State Questions and Hypothesis → Data Collection → Statistical Inference → Accept or Reject Hypothesis

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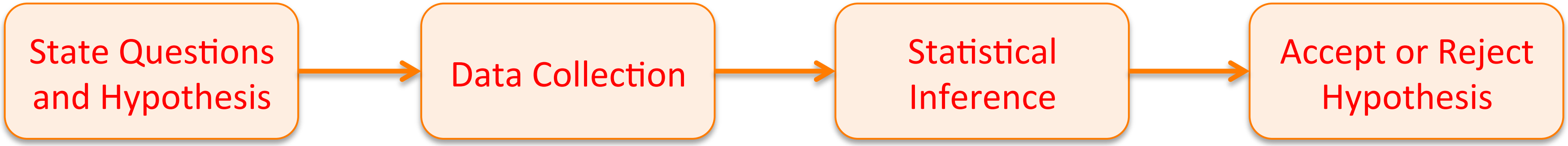
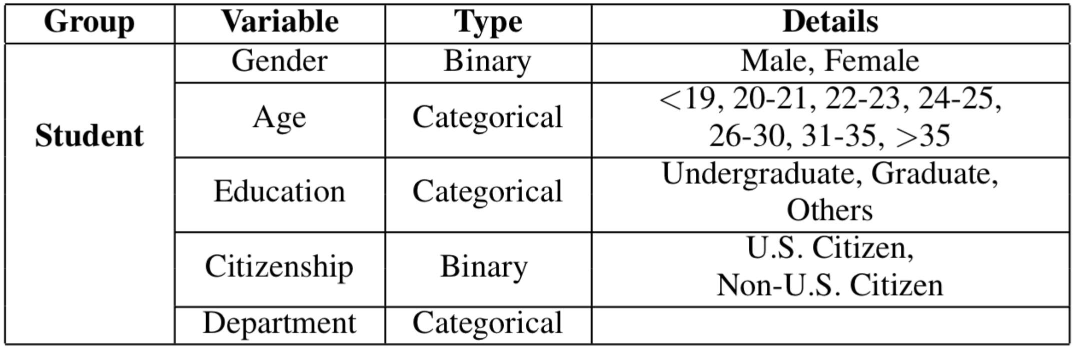


Example 1 - User Susceptibility

- Question
  - What roles *gender, age, education-level, citizenship,* and *department* play in the compromise of student accounts?
- Data
  - Student victims: *242* at UofM from 2009 to 2011, *130* at UIUC in 2011
  - Aggregated Demographics for the total student population



Group	Variable	Type	Details
Student	Gender	Binary	Male, Female
	Age	Categorical	<19, 20-21, 22-23, 24-25, 26-30, 31-35, >35
	Education	Categorical	Undergraduate, Graduate, Others
	Citizenship	Binary	U.S. Citizen, Non-U.S. Citizen
	Department	Categorical	

Example 1 - User Susceptibility

- Methodology: Multivariate Linear Regression
  - Predict the effect of one factor, *holding other factors constant*.
  - Example: Age and Education Level
    - Simple distribution -> 20-21, undergraduate
    - Undergraduate students has more people in age 20-21 than graduate students
    - Which is the real significant factor? Or both?
  - Logistic Regression Model:

$$L = a + \sum B_i X_i. \qquad L = \ln \frac{\hat{p}}{1 - \hat{p}}.$$

    - Null Hypothesis Ho: Bi = 0 (Variable Xi is not statistically significant in predicting user susceptibility)
    - Test Statistics: p-value < 0.05

Example 1 - User Susceptibility

- Results

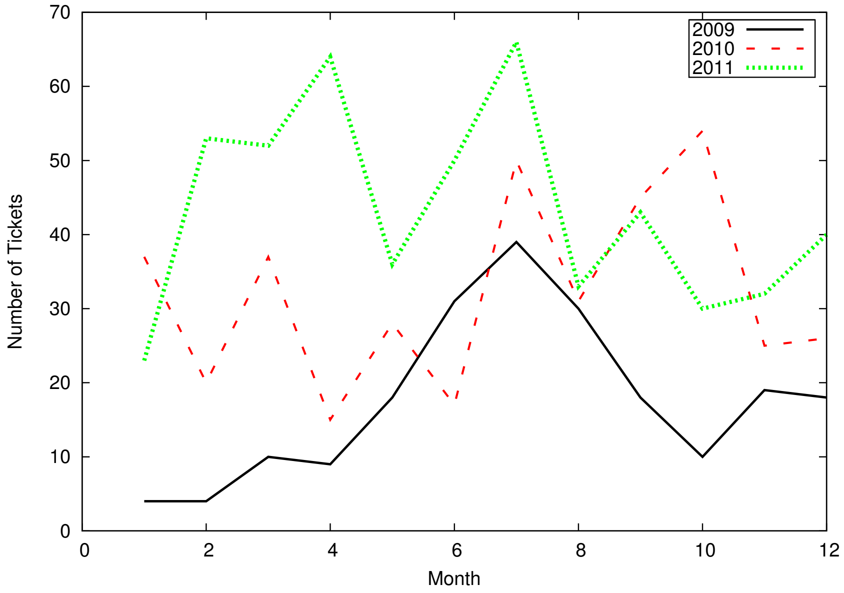
Factor	University	Year	p-value	Coef.
Undergraduate	UofM	2009	0.009	2.957
		2010	<0.001	3.520
		2011	0.020	3.489
	UIUC	2011	0.958	-10.733
Age (20-21)	UofM	2009	0.002	1.219
		2010	0.004	0.823
		2011	0.017	0.896
	UIUC	2011	0.410	-0.472
Citizenship	UofM	2009	0.520	0.315
		2010	0.659	-0.126
		2011	0.128	-0.460
	UIUC	2011	0.007	0.5433

Disagreement between the two universities

Gender is not statistically significant!

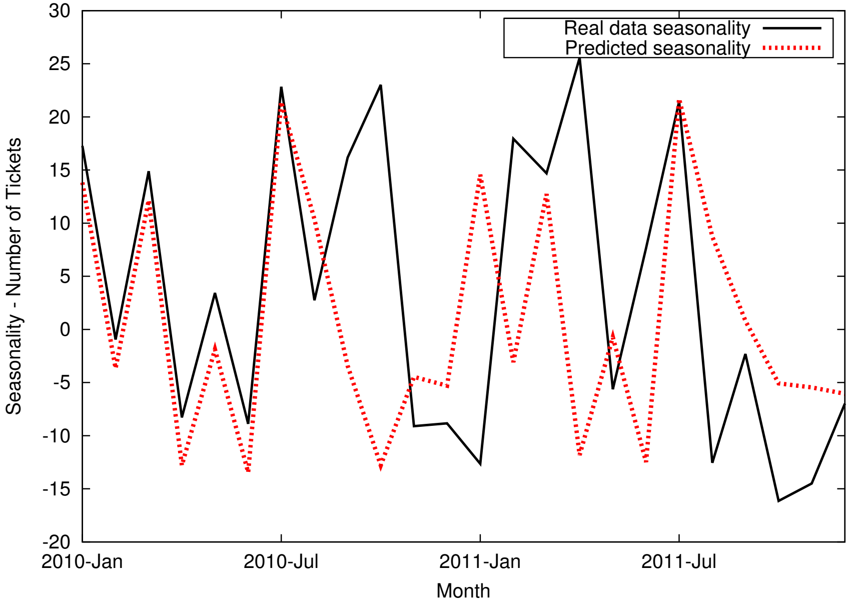
Example 2 - Temporal Factor

- Question
  - Whether the incidence of compromises varies at different time of the year?
- Data
  - Monthly number of tickets at UofM from 2009 to 2011



Example 2 - Temporal Factor

- Methodology: Time series data analysis
  - "Holt-Winters" exponential smoothing procedure
    - Long-term trend + Seasonality
- Result
  - No seasonality pattern in the monthly number of tickets



Creation time ≠ Compromise time

Example 3 - Password Policy

- Question
  - Whether accounts with weak passwords are more likely to be compromised?
- Data
  - Password-cracking performed at UofM (2012)

	# of total	# of compromised	Pr (compromise)
Weak Password	2,284	12	0.525%
Total Population	550,000	380	0.069%

Example 3 - Password Policy

- Methodology: Test of Homogeneity
  - Whether the response of identifiable sub-populations differ from those of others
  - Null Hypothesis H_o: users who have weak passwords have the same probability to be compromised as other users
  - Test statistics: deviance; Confidence level: p-value < 0.05
- Result
  - Test statistics of deviance of 28.09 and a p-value of 1.16^{-16}
  - Reject Null Hypothesis, and conclude that the users, who use weak passwords, have a higher probability to be compromised

Is weak password the reason of compromise?

But are the limited number of potentially impacted accounts worth our effort?

Discussions

- Are the questions meaningful?

Actionable? Proactive or Reactive?

- Is it the right data?

Quality? Sensitivity?

- Are we using right analysis techniques?

Observation ≠ Statistical Inference
Correlation ≠ Causality

- How to reproduce the measurement?
  - Continuous measurement
  - Reproduce across multiple organizations

Generalized measurement metrics and techniques
Data collection and sharing platform

- How to form actionable strategies based on those metrics?

Results ≠ Strategy
Strategy ≠ Success