

IoT challenges

State of the art

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Outline

1. Introduction
2. First contribution
3. Second contribution
4. Third contribution
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6. First contribution

Context

What is IoT ?

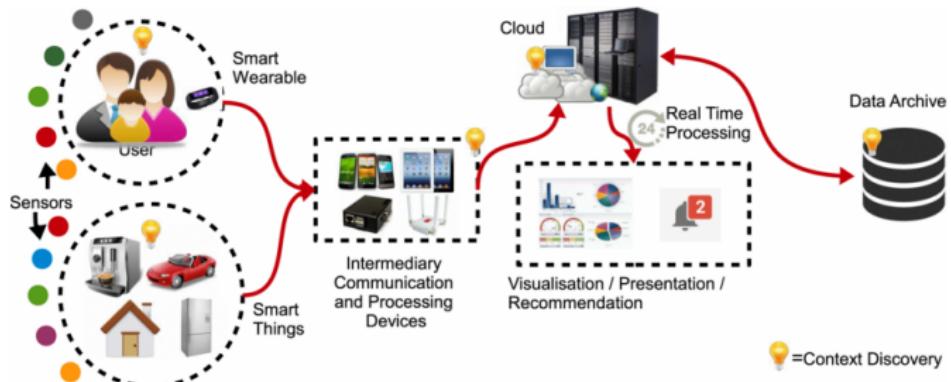


Figure 1: IoT platform.



Figure 2: IoT challenges.

Problematic

Where is the problem ?

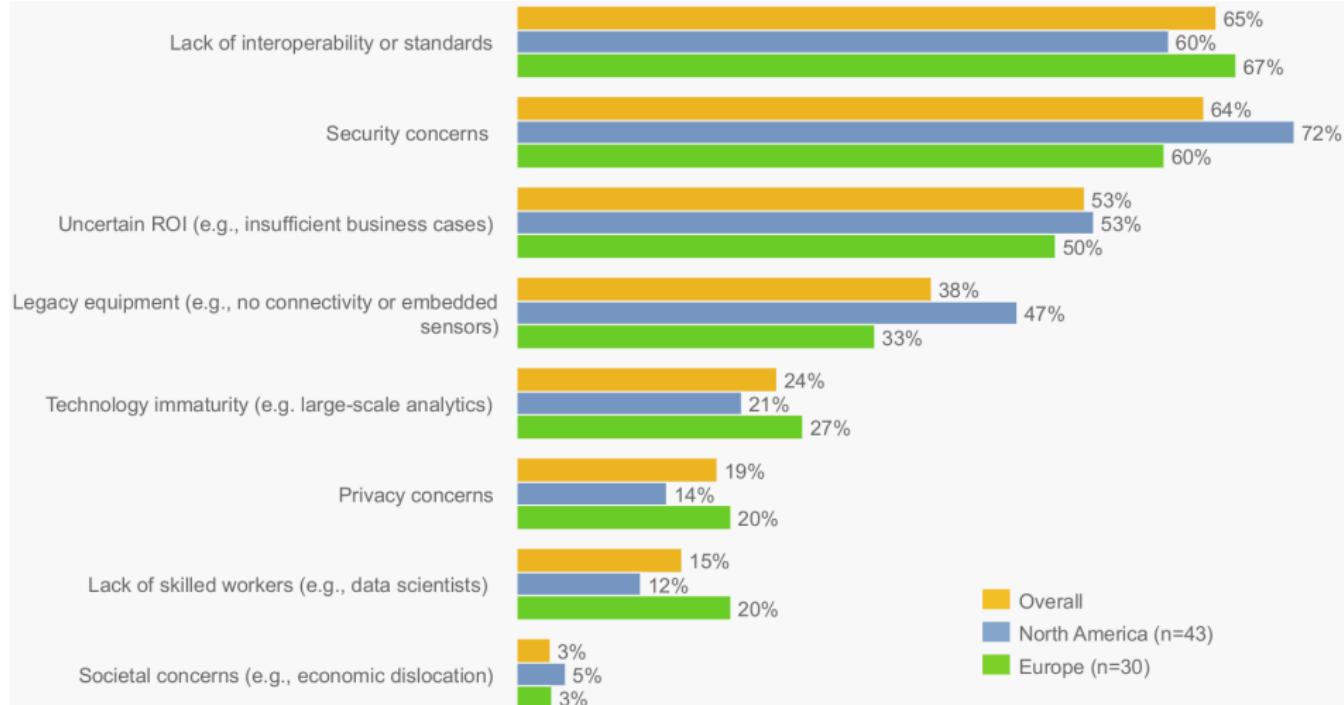


Figure 3: Key barriers in adopting the Industrial Internet [industrialinternetofthings_executive_].

Problematic

Where is the problem ?

- ➡ Some network configuration are static and not adaptive to the application
 - ▶ Decision and optimisation problem..
 - ▶ Various network access
 - ▶ Various configuration of each network access
 - ▶ Lack of selection tools
- ➡ Users have to select the network and the application
 - ▶ How to select the **best** network.
 - ▶ How to select the network required by the application.

Context

Introduction

- ▶ IoT Applications
 - ▶ Health care
 - ▶ **Transportation**
 - ▶ Industry
 - ▶ Market
 - ▶ School
 - ▶ Vehicles
 - ▶ Smart Home
 - ▶ Agriculture



Figure ??: IoT Applications

Problematic

Where is the problem [2] ?

Bandwidth (*BW*) Spreading Factor (*SF*) Coding Rate (*CR*) Transmission Power (*Tx*) Receiver Sensitivity (*RS*) Signal Noise Rate (*SNR*) Data Rate (*DR*) ,Air Time (*AT*), Payload length (*PktL*)

Setting	Values	Rewards	Costs
<i>BW</i>	$7.8 \rightarrow 500\text{kHz}$	<i>DR</i>	<i>RS, Range</i>
<i>SF</i>	$2^6 \rightarrow 2^{12}$	<i>RS, Range</i>	<i>DR, SNR, PktL, Tx</i>
<i>CR</i>	$4/5 \rightarrow 4/8$	Resilience	<i>PktL, Tx, AT</i>
<i>Tx</i>	$-4 \rightarrow 20\text{dBm}$	<i>SNR</i>	<i>Tx</i>

Table 1: [1]

Technical choice

Implementation

- ▶ ZOLERTIA RE-MOTE
 - ▶ Low consumption component
 - ▶ ADC port for placing sensors on it
- ▶ CONTIKI OS
 - ▶ Operating system for wireless and low power development
 - ▶ Support for newer standards (6LowPAN, RPL, CoAP, MQTT)
- ▶ 6LowPAN
 - ▶ Based on IPv6 and IEEE 802.15.4
 - ▶ IPv6-based network with low power consumption
 - ▶ Ability to create a mesh network
- ▶ Sending packages
 - ▶ UDP in the 6LowPAN network
 - ▶ MQTT between the cloud platform and the router

Motivations

Who & why cares with such problems ?

- ▶ a
- ▶ Lake of selective tools
- ▶ How to select the **best** access point

QoS Analysis

- ▶ a
- ▶ Lake of selective tools
- ▶ How to select the **best** access point

Threats

- ▶ a
- ▶ Lake of selective tools
- ▶ How to select the **best** access point



Figure 4: Communication diversity.

Goal

What is the goal ?

- ▶▶ Allow heterogeneous network to communicate
 - ▶▶ QoS Analysis
 - ▶▶ Threats
-
- ▶ How to select the **best** access point
 - ▶ Allow heterogeneous network to communicate
 - ▶ QoS Analysis
 - ▶ Threats



Figure 5: wsn-IoT.

Goal

What is the goal ?

- ▶ ▶ Allow heterogeneous network to communicate
- ▶ ▶ QoS Analysis
- ▶ ▶ Threats

- ▶ How to select the **best** access point
 - ▶ Allow heterogeneous network to communicate
 - ▶ ▶ QoS Analysis
 - ▶ ▶ Threats



Figure 5: wsn-IoT.

Map the network to service requirement ?

Challenges

Where is the difficulty ?

- Reasonable and acceptable delay before the decision appears.
- Cope with the different view points and goals of the operators and the users.
- React to the changing environment conditions.
- Allow any type of inputs and to be applicable to any type of ANs.
- Handle the increasing number of RATs and the large number of criteria.

Contributions

Contributions

- ▶ Use cases (Requirements)
 - ▶ Smart building: Videos, Voice, Text.
 - ▶ Smart traffic: Videos, Voice, Text
- ▶ Environments
 - ▶ Rural/Urban
 - ▶ Static/Mobile
 - ▶ Temperature
- ▶ Scenarios
 - ▶ For each application protocol (MQTT, COAP, XMPP)
 - ▶ For each network protocol (Star, Mesh)
 - ▶ For each MAC protocol (LoRaWan, Sigfox, ...)
- ▶ Algorithms
 - ▶ Input:
 - * Service QoS metrics requirements
 - * MAC configuration (SF, CR, BW, ...)
 - * Network QoS metrics
 - ▶ Method:
 - * MADM, Game, Neural
 - ▶ Outputs:
 - * Ranked networks

Contributions

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- ▶ Use cases (Requirements)
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Theoretical, Simulation & Real environment

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Related work

Comparison

Paper	A1	A2	A3	A4

Table 2: An example table.

Related work

Comparison

Paper	A1	A2	A3	A4

Table 3: An example table.

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1. Bandit Algorithm
2. Genetic Algorithm
3. Marcov chain
4. Game theory

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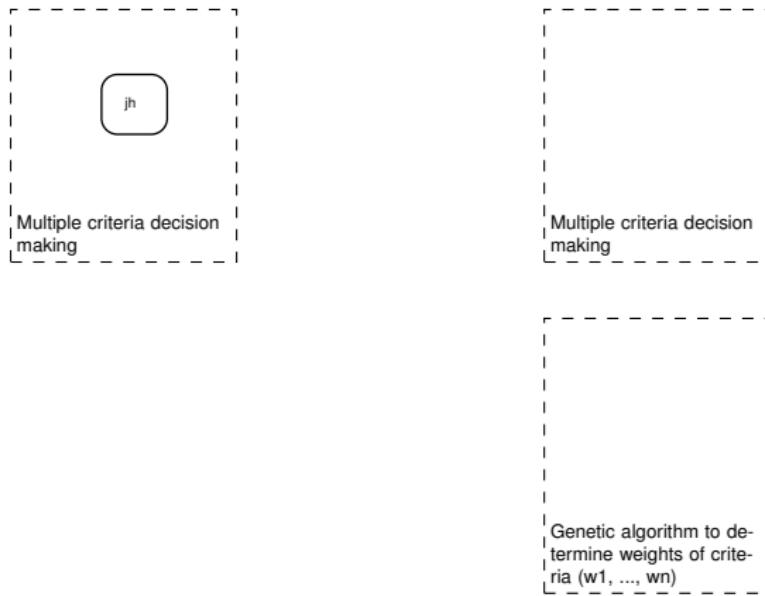
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Multi-Armed-Bandit Algorithm

Methods

- Arms: $K = 1, \dots, K$
- Decision: $T = 1, \dots, T$
- Reward: X_t^k with $\mu_t^k = E [X_t^k]$
 - Best reward: X_t^* with $\mu_t^* = \max \mu_t^k, k \in K$

Binary code analysis: Why?



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Genetic Algorithm

Methods [alkhawiani_access_2008a]

- Heterogeneous wireless network: (RAT 1 ,RAT 2 ,...,RAT n)
- Criteria up to i (c_1, c_2, \dots, c_i) the operators, the applications, and the network conditions.
-
- The different sets of scores (d_1, d_2, \dots, d_i) are sent to the MCDM in the second component.
- GA component assigns a suitable weight (w_1, w_2, \dots, w_i)

Genetic Algorithm

Methods



→ S = SF12, BW125, 4/8, 17 dBm

→ Input:

→ Problem: $f(x) = \max(x^2)$, $x \in [0, 32]$

* $x_1 : 01101_b$

* $x_2 : 11000_b$

* $x_3 : 01000_b$

* $x_4 : 10011_b$

→ Method: Genetic algorithm

→ Generate a set of random possible solution

→ Test each solution and see how good it is (ranking)

* Remove some bad solutions

* Duplicate some good solutions

* Make small changes to some of them (Crossover, Mutation)

→ Output:

→ $x_1 : 01101$ (169) (14.4)

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Marcov chain

Methods

$$V(s, \pi) = \mathbb{E}_s^\pi \left(\sum_{k=0}^{\inf} \gamma^k \cdot r(s_k, a_k) \right), s \in \mathbb{S} \quad (1)$$

$$r(s_k, a_k) = G_k \cdot PRR(a_k) \quad (2)$$

$$\pi^* = \arg \max_{\pi} V(s, \pi) \quad (3)$$

$$PRR = (1 - BER)^L \quad (4)$$

$$BER = 10^{\alpha e^{\beta SNR}} \quad (5)$$

Marcov chain

Methods

HGHGJ

$$V(s, \pi) = \mathbb{E}_s^\pi \left(\sum_{k=0}^{\inf} \gamma^k \cdot r(s_k, a_k) \right), s \in \mathbb{S} \quad (1)$$

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$$PRR = (1 - BER)^L \quad (4)$$

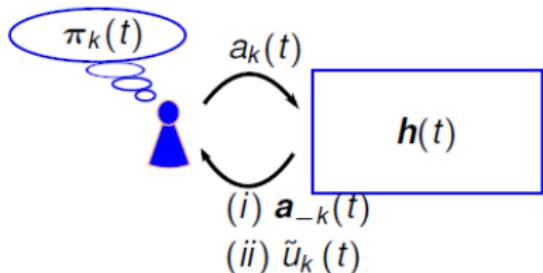
$$BER = 10^{\alpha e^{\beta SNR}} \quad (5)$$

Marcov chain

Methods

Learning Iterative Steps:

- **Choose** action $a_k(t) \sim \pi_k(t)$.
- **Observe** game outcome, e.g.,
 $a_{-k}(t)$
 $u_k(a_k(t), a_{-k}(t))$.
- **Improve** $\pi_k(t+1)$.



Thus, we can expect that: $\forall k \in \mathcal{K}$,

$$\pi_k(t) \xrightarrow{t \rightarrow \infty} \pi_k^* \quad (1)$$

$$\bar{u}_k(\pi_k(t), \pi_{-k}(t)) \xrightarrow{t \rightarrow \infty} \bar{u}_k(\pi_k^*, \pi_{-k}^*) \quad (2)$$

where, $\pi^* = (\pi_1^*, \dots, \pi_K^*)$ is a NE strategy profile.

Figure 6: .

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Game theory

Methods

- ▶ Players: $K = \{1, \dots, K\}$
- ▶ Strategies: $S = S_1 \times \dots \times S_K$
 - ▶ S_k is the strategy set of the k^{th} player.
- ▶ Rewards: $u_k : S \rightarrow R_+$ and is denoted by $r_k(s_k, s_{-k})$
 - ▶ $s_{-k} = (s_1, \dots, s_{k-1}, s_{k+1}, \dots, s_K) \in S_1 \times \dots \times S_{k-1} \times S_{k+1} \times \dots \times S_K$

... (step 2)

Methods



... (step 3)

Methods



... (step 4)

Methods



Results

Comparison

Table 4

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Experimentation

Experimentation

- a
- b

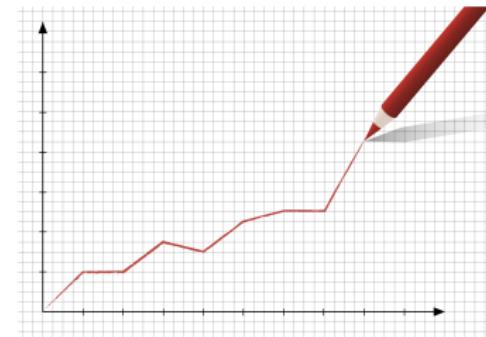


Figure 7: .

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Results

Comparison

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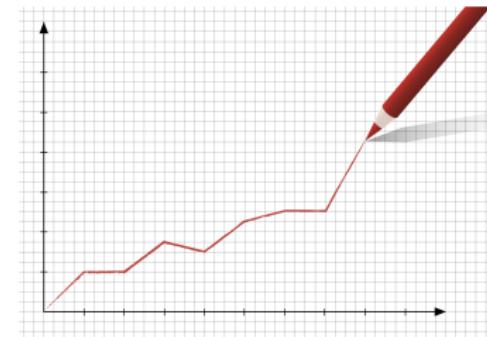


Figure 8: .

Outline

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Discussion

→ a

→ b

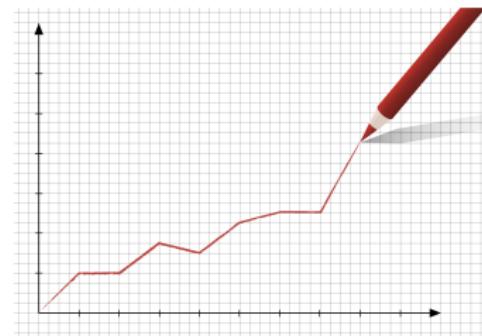


Figure 9: .

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Related work

Comparison

Paper	A1	A2	A3	A4

Table 5: An example table.

Related work

Comparison

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Table 6: An example table.

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... (step 2)

Methods



... (step 3)

Methods



... (step 4)

Methods



Results

Comparison

Table 7

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Experimentation

Experimentation

- a
- b

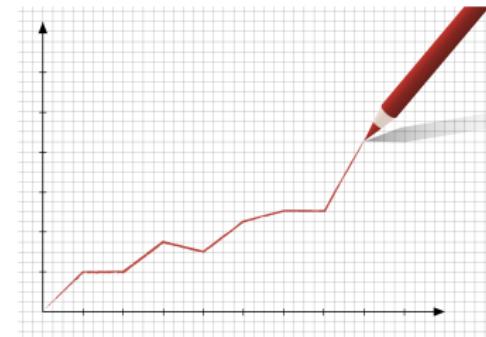


Figure 10: .

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Results

Comparison

- a
- b

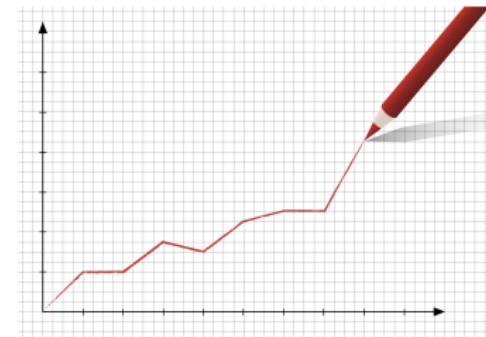


Figure 11: .

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Discussion

→ a

→ b

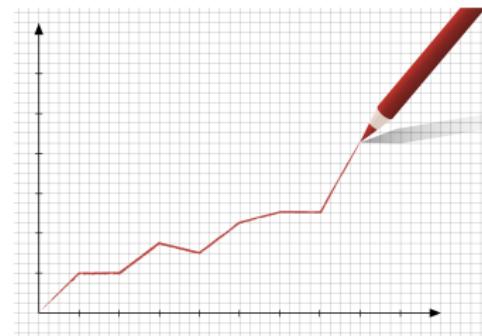


Figure 12: .

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Related work

Comparison

Paper	A1	A2	A3	A4

Table 8: An example table.

Related work

Comparison

Paper	A1	A2	A3	A4

Table 9: An example table.

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... (step 1)

Methods



... (step 2)

Methods



... (step 3)

Methods



... (step 4)

Methods



Results

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Experimentation

Experimentation

- a
- b

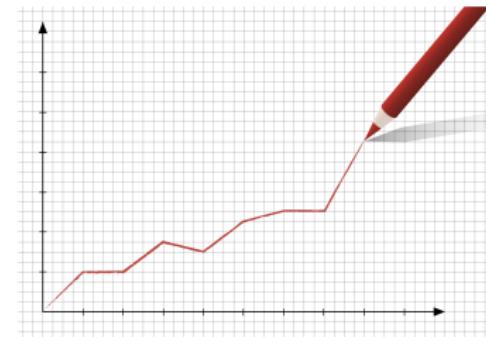


Figure 13: .

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Comparison

- a
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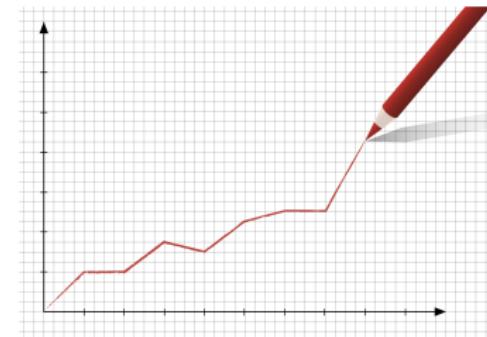


Figure 14: .

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Discussion

→ a

→ b

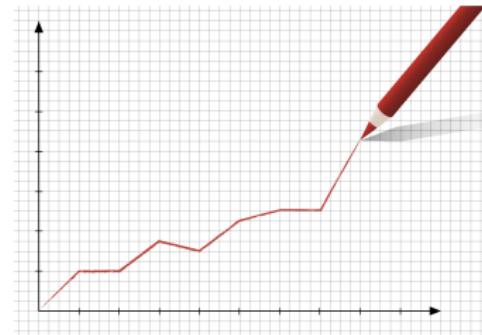


Figure 15: .

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Conclusion

Our main goal was



Our main contribution was



Our main results was



Future Challenges

Conclusion

Our future goal was



Future Challenges

Conclusion

Our future goal was



Thank you !

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Related work

Comparison

Works	Contribution	Goal
[3] Protect U	Classification of interlocutors	Friends lists management
[4] Privacy Wizard	Friends Classification	Permission Configuration
[5] SocialMarket	Common Interests	Assessment of Trust Relationships
[6] PARE	Information Leakage	Evaluation of Information Dissemination
[7] LENS	Spam Protection	Trusted Emitters Evaluation
[8] SocialEmail	Classify msg by paths	Evaluate message reliability
[9] Privacy Index	Visibility, sensitivity	Msg exposure assessment

Table 11: Contributions from existing work.

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Step 1: Individual vulnerability measurement

Method

Parameter	Value
Network connection	Private, Public [1:2]
Technology	Ethernet, 5G, 4G, Wifi [1:4]
Operating system	Windows, Unix, Mac [1:3]
Web browser	Firefox, Chrome, Opera, ... [1:10]
Password strength	low, medium, strength [1:3]
Sessions opened	counter [1:10]
TLS version	v1.0, v1.1, v1.2, v1.3 [1:4]

Table 12: Individual Vulnerability parameter

$$Y = \sum_i^n \frac{w * V}{n} \quad (6)$$

- **Y:** Individual vulnerability
- **w:** Weight of each vulnerability
- **V:** Scores mentioned above

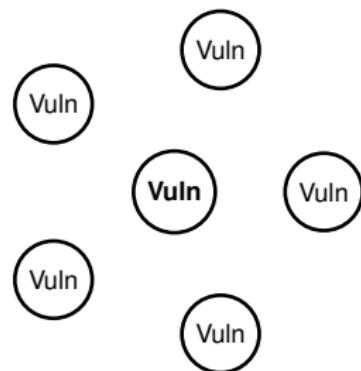


Figure 16: Individual vulnerability level.

Step 2: Users reputation estimation

Method

Parameter	Value
Frequency of msg exchanged	continuous
Discussion time	continuous
% of messages exchanged	cipher, signed or clear [1:3]
Message type exchanged	Text, images, videos, script [1:4]

Table 13: Trust grant features

$$\alpha = P(\text{reputation}) = P(X \geq 1) = 1 - (1 - P(\text{trust}))^n \quad (7)$$

- Where,
 - **X**: trust grant, random variable, $X \sim B(n,p)$
 - **n**: deg(node)
 - **P(X=1)**: The probability of being assigned one trust grant by an interlocutor

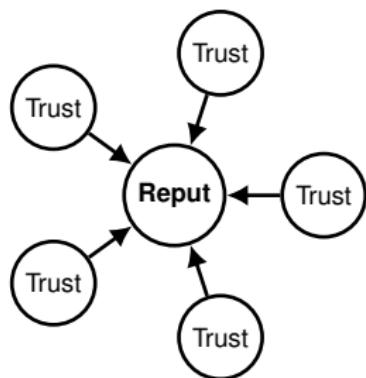


Figure 17: Reputation level.

Step 3: Social vulnerability measurement

Freidkin's theory of social influence

- Input (Features):

- $Y^{(1)}$ = Vector of the individual vulnerabilities of N users (eq 6)
- α = The level of reputation (influence) of each user (eq 7)
- M = Adjacency matrix $N \times N$

- Model:

$$Y^{(t)} = \alpha M Y^{(t-1)} + (1 - \alpha) Y^{(t-1)} \quad (8)$$

- Output:

- $Y^{(t)}$ = Vector of the social vulnerabilities of the N users

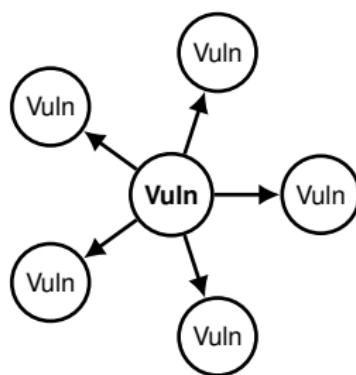


Figure 18: Social vulnerability.

Step 3: Social vulnerability measurement

Freidkin's theory of social influence

Formal properties of the model:

- When a user's influence is high, the model is reduced to:
 - average vulnerabilities of his friends weighted by their trust levels.

$$Y^{(t)} = \mathbf{1} * \mathbf{M} Y^{(t-1)} + (1 - \mathbf{1}) Y^{(t-1)} \quad (8)$$

$$Y^{(t)} = \mathbf{M} Y^{(t-1)}$$

- In the absence of influence, the model is reduced to:
 - his own vulnerability weighted by the level of mistrust of his friends

$$Y^{(t)} = 0 * \mathbf{M} Y^{(t-1)} + (1 - 0) Y^{(t-1)} \quad (8)$$

$$Y^{(t)} = Y^{(t-1)}$$

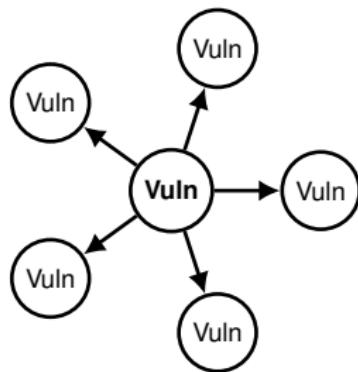


Figure 19: Social vulnerability.

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Email datasets

Experimentation

Parameter	Value
Users	958
Messages	6966
Diameter	958
# of msg on average	2.413361
Msg density	0.00252
Modularity	0.654600
Average distance	3.042114

Table 14: Enron dataset properties.



Figure 20: Enron logo.

Parameter	Value
Users	5885
Messages	26547
Diameter	2096
# of msg on average	9.02192
Msg density	0.001533
Modularity	0.86526
Average distance	3.914097

Table 15: Caliopen dataset properties.



Figure 21: Caliopen logo.

Outline

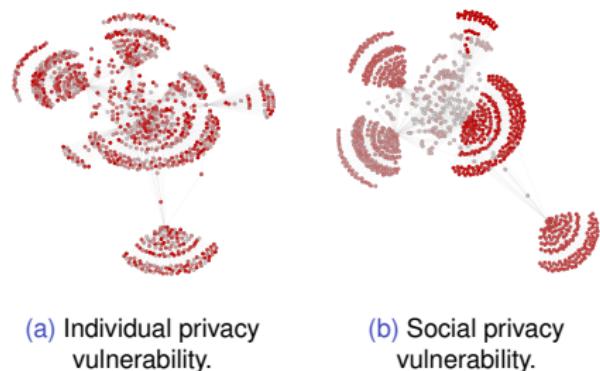
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Results

Comparison

Initial values:

- generated randomly (normal distribution)
- represent individual vulnerabilities.
- dark color = highly infected



Final values:

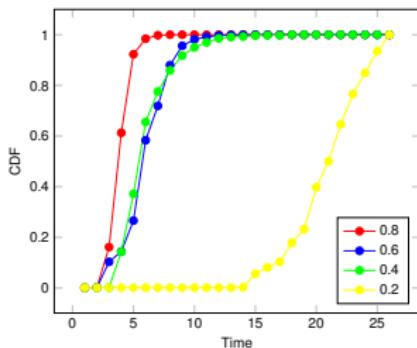
- obtained after convergence.
- represent social vulnerabilities.

Figure 22: Individual & Social privacy vulnerabilities.

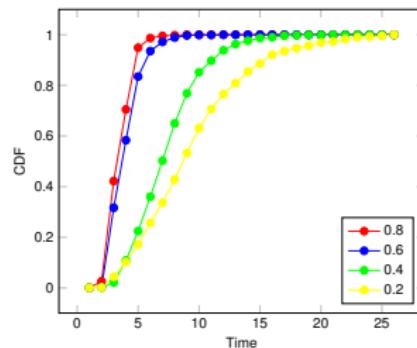
User ID	Individual Vul	Social Vul
34	0.84	0.67
67	0.12	0.87
206	0.76	0.33
588	0.23	0.78

Table 16: Individual and social privacy vulnerabilities.

Results exploitation



(a) Enron dataset.

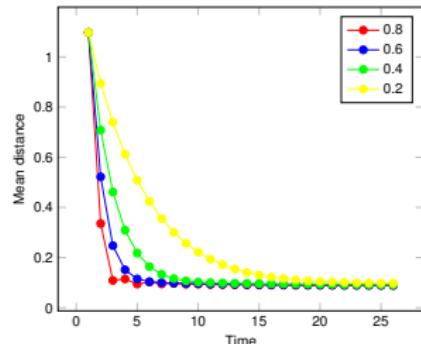


(b) Caliopen dataset.

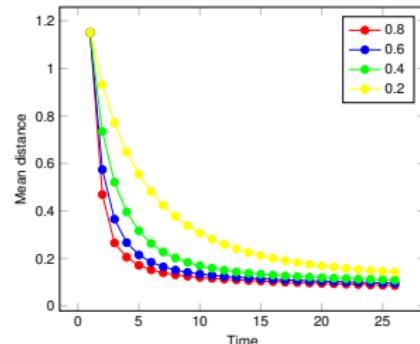
Figure 23: Cumulative distribution function of infected users.

- Figures shows the CDF of the vulnerability diffusion process.
- The vulnerability diffusion process increases as the reputation level of vulnerable users increases.
- Users with high reputation values contribute significantly to the diffusion
 - They spread their vulnerabilities quickly and widely through the network.

Results exploitation



(a) Enron dataset.



(b) Caliopen dataset.

Figure 24: Convergence of the diffusion process.

- ▶ The process converge when the mean distance between social vulnerability scores is the minimum.
- ▶ Assigning trust to vulnerable users allows them to achieve a high level of reputation.
- ▶ Consequently, they infect all other vulnerability values.

Outline

- 1. Introduction
- 2. First contribution
- 3. Second contribution
 - 1. Related work
 - 2. Diffusion process
 - 3. Experimentation
 - 4. Results
 - 5. Discussion**
- 4. Third contribution
- 5. Conclusion
- 6. First contribution

Discussion

- ➡ The purpose of this work is to simulate a diffusion process of individual vulnerabilities.
 - ➡ The vulnerability of one user is the vulnerability of all users.
 - ➡ At the end of the diffusion (convergence), all users gets their social vulnerability scores.
- ➡ Future work
 - ➡ To propose mechanisms to improve the reputation of non-vulnerable users.
 - * Suggest well known interlocutors with acceptable vulnerability scores.
 - ➡ To propose mechanisms to improve the vulnerability of reputed users.
 - * recommend configurations and softwares.

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Thank you

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