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# Lattice-based Contextual Integrity Analysis of Social Network Privacy Policies

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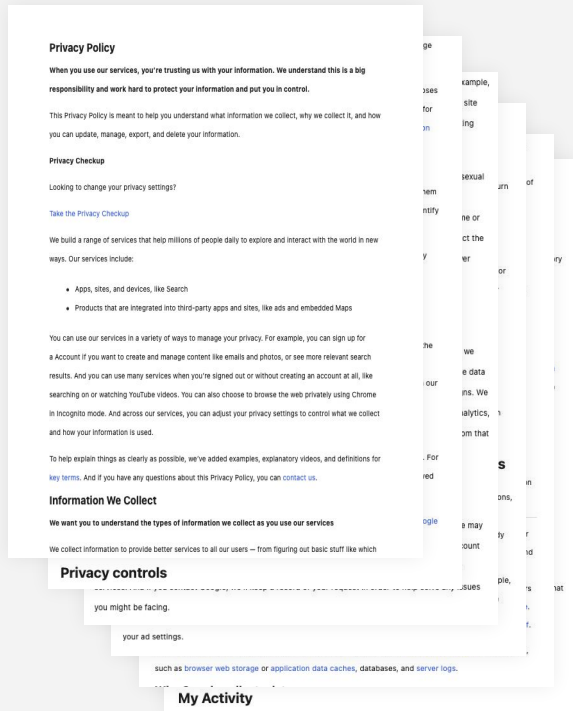
# Lattice-based Contextual Integrity Analysis

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- **Lattice-based Contextual Integrity Analysis** (LCIA) is a four-phase privacy policy analysis framework which aims to:
  - Identify and quantify ambiguity within online social network (OSN) privacy policies
  - Evaluate and rank the privacy practices of OSNs
  - Allow us to make predictions about how likely an OSN's privacy policy is to mislead users with regard to its information flow practices relative to other OSNs



# Problem Description



- Privacy policies are often long and confusing
- Difficult for users to know exactly what information an OSN collects
- More difficult for users to know exactly how their information is used and shared



# Background I

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- LCIA relies on the **Contextual Integrity** framework
  - Nissenbaum, H. “Privacy in Context: Technology, Policy, and the Integrity of Social Life.” *Stanford University Press* (2009)
  - Shvartzshnaider, Y., Apthorpe, N., Feamster, N., & Nissenbaum, H. “Going against the (Appropriate) Flow: A Contextual Integrity Approach to Privacy Policy Analysis.” *AAAI* (2019)

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We **encrypt** all of the information that **we** collect from **you**.

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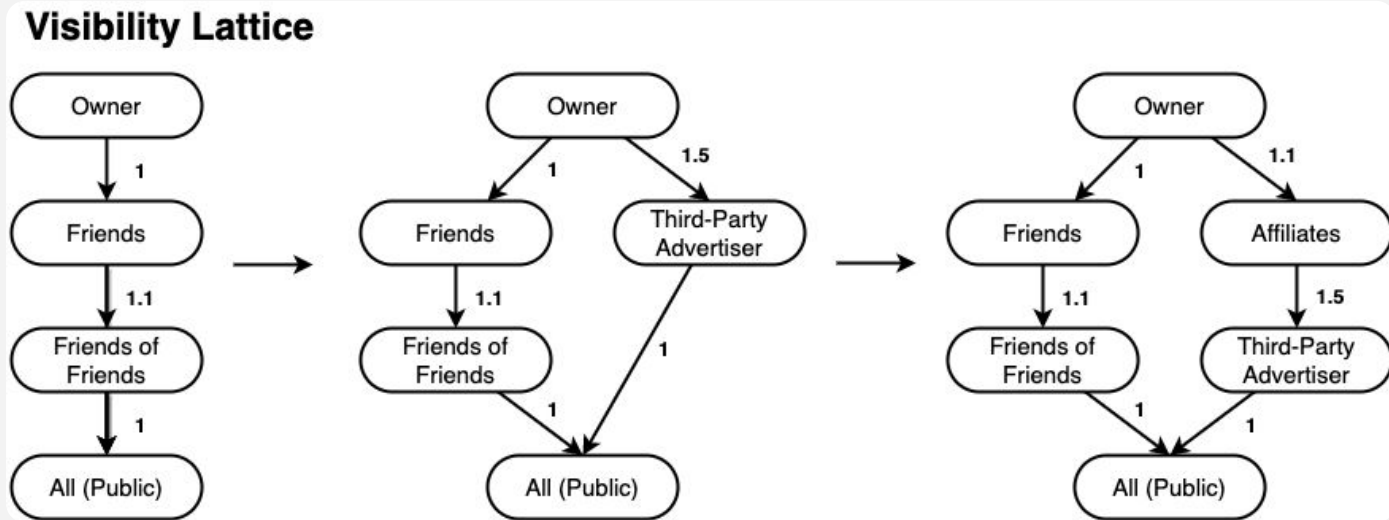
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Principle]



# Background II

- LCIA relies on [lattice representations of privacy practices](#)
  - Ghazinour, K., Majedi, M., and Barker, K. "A Lattice-Based Privacy Aware Access Control Model." *2009 International Conference on Computational Science and Engineering* (2009)



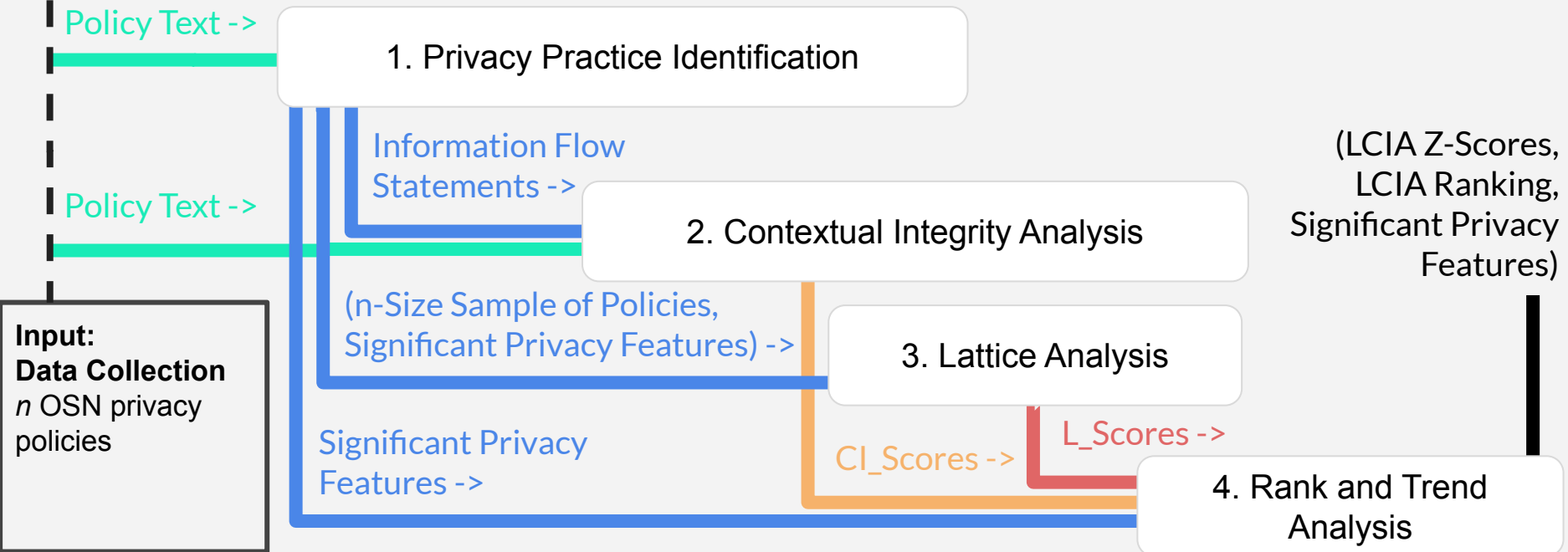
# Research Questions

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- RQ-1.* What are the similarities and differences in the way existing OSNs define, protect, and violate user privacy?
- RQ-2.* How can OSN privacy practices be compared in a standardized way?
- RQ-3.* What relationships exist between poor OSN privacy practices, poor privacy policies, and gaps in user understanding of privacy?

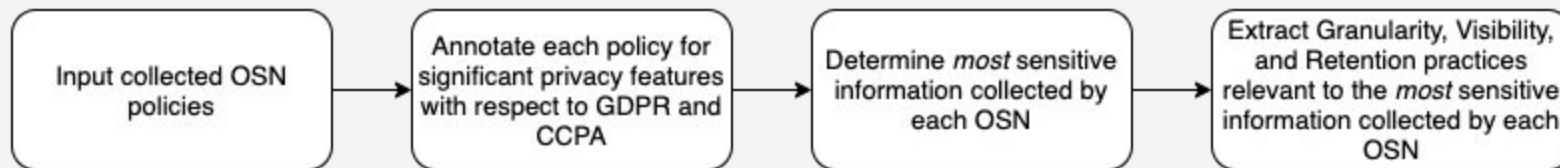


# LCIA Methodology



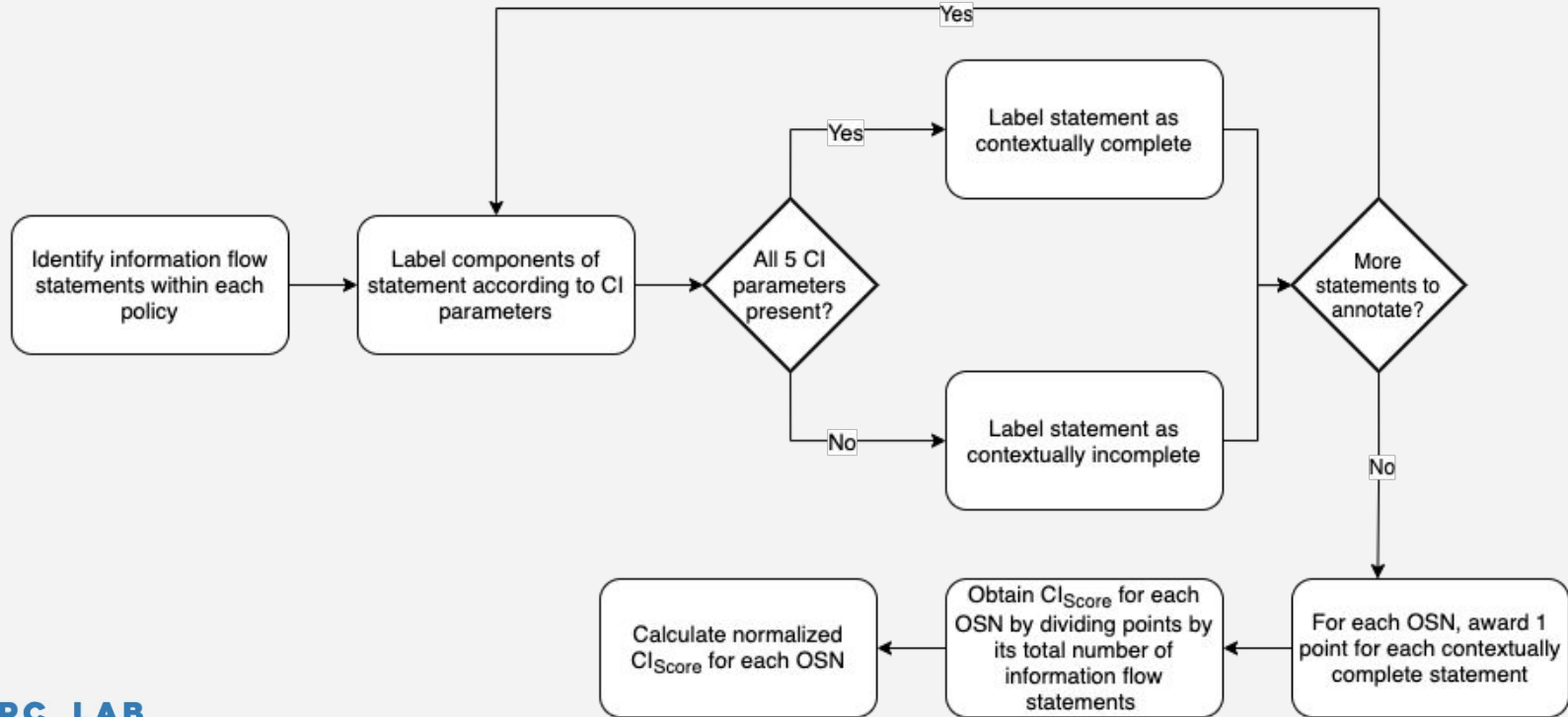
# Phase 1: Privacy Practice Identification

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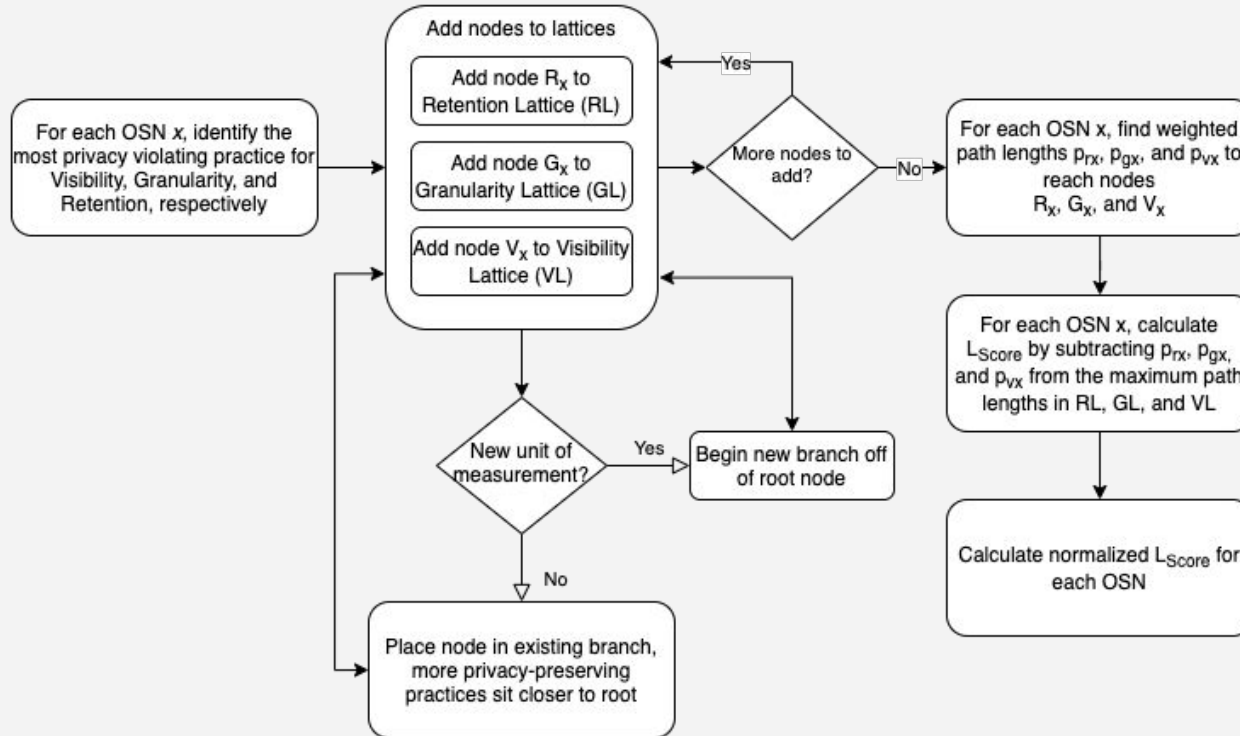




# Phase 2: Contextual Integrity Analysis



# Phase 3: Lattice Analysis



# Phase 4: Rank and Trend Analysis

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- Sum the normalized  $CI_{\text{Score}}$  and  $L_{\text{Score}}$  of each OSN to form a combined  $LCI_{\text{Score}}$
- Rank the OSNs according to their  $LCI_{\text{Score}}$
- Identify trends in the analyzed sample of OSNs



# Preliminary Analysis - Data Collection

Category	OSNs
<b>General</b>	<b>Facebook</b> , Twitter, Reddit, Tagged, VK
Health	Samsung Health, CaringBridge
Image Sharing	Instagram, Imgur, Flickr, Pinterest, DeviantArt, *Ello.co, *PixelFed, We ♥ It
Video Sharing	YouTube, Twitch, Vimeo, TikTok
Dating	Tinder, Grindr, Match, Bumble
Blogging	Tumblr, Blogger, Quora, OpenDiary
Music Sharing	SoundCloud, MySpace
Text Sharing	Goodreads, Wattpad
<b>Professional Networking</b>	<b>LinkedIn</b> , NearPeer
Voice Chat	Discord, Skype, Microsoft Teams, TeamSpeak
Messaging	WhatsApp, Facebook Messenger, Snapchat, Slack, Moco, *Mastodon, *Element, *Signal, *Telegram
Content Discovery	Mix
Business Discovery	Yelp, FourSquare
Gaming	Habbo

- Compiled a list of 50 social networks in 14 categories
- Filtered for networks supporting n-removed connections
- Randomly selected  $n$  samples from each category
- Obtained each OSN's privacy using our *PolicyAccumulator*

# Preliminary Results

OSN	Phase 2	Phase 3	Phase 4
VK	0.97	0.30	0.78
Facebook	<b>-1.88</b>	<b>-0.99</b>	<b>-1.76</b>
CaringBridge	0.76	<b>1.16</b>	<b>1.18</b>
DeviantArt	-1.22	<b>1.59</b>	0.23
PixelFed	0.71	0.73	0.88
YouTube	<b>-1.78</b>	<b>-1.85</b>	<b>-2.23</b>
Tumblr	-0.31	0.30	-0.01
SoundCloud	0.10	-0.99	-0.55
Wattpad	0.61	0.30	0.56
LinkedIn	0.46	0.30	0.47
Snapchat	0.15	0.73	0.54
Yelp	0.86	-0.99	-0.08
Habbo	0.56	-0.56	0

**YouTube** (Least Privacy-Preserving)

Facebook  
 SoundCloud  
 Yelp  
 Tumblr  
 Habbo  
 DeviantArt  
 LinkedIn  
 Snapchat  
 Wattpad  
 VK  
 PixelFed

**CaringBridge** (Most Privacy-Preserving)

# Conclusion

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- We presented a four-phase privacy policy analysis framework
  - Systematically compares the privacy practices of OSNs
- We demonstrated LCIA's potential effectiveness
  - Performed a preliminary evaluation of LCIA on 13 OSN's privacy policies
  - Ranked social networks based on overall privacy practices, revealing cases where users may misunderstand privacy practices



# Future Work

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- Leverage unsupervised machine learning in annotation process
- Conduct a user study on users' perception of privacy violation
- Evaluation of larger dataset to reveal generalizable insights
- Implementation
  - Real time analysis of privacy policies
  - Policy analysis prior to application publication



# Thank you!

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Slides will be available at [skaplan.io/LCIA](https://skaplan.io/LCIA)  
and [dylanbulmer.com/publications/LCIA](https://dylanbulmer.com/publications/LCIA)

**Reach out with any questions**

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