Australia's National Science Agency

{Privacy Policy} in Practice: Challenges, Implications, and Solutions

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University of Edinburgh

March 2024

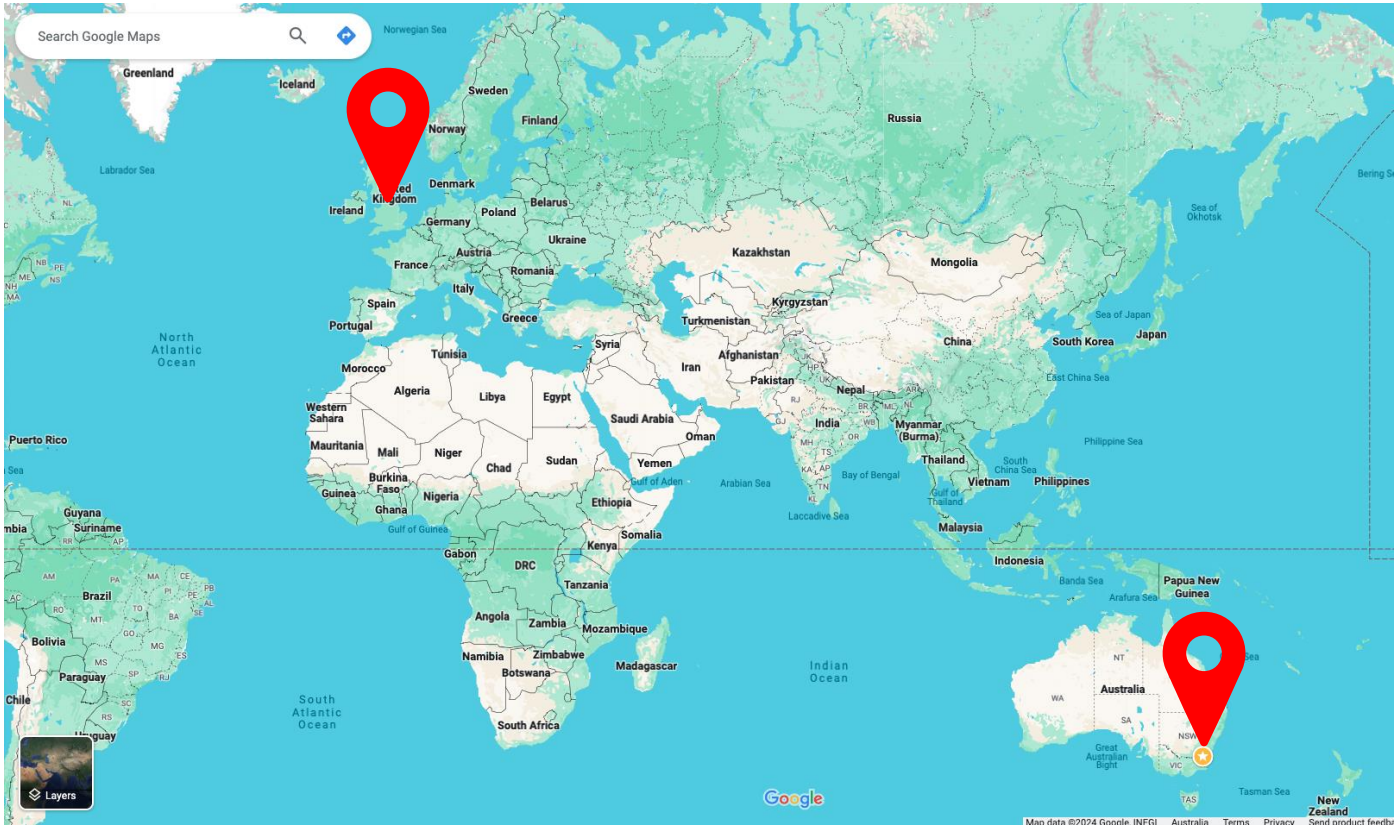
Self-introduction

- Shidong Pan (潘士东)

- I’m an about-to-finish PhD affiliated to:
  - School of Computing, Australia National Univeristy
  - Responsible AI Group, CSIRO’s Data61
  - Was a visiting PhD student at Singapore Management University (SMU).

My research primarily focuses on **Usable Privacy**, integrating disciplines such as Software Engineering, Cybersecurity, and Human-Computer Interaction. Additionally, I have a broad interest in various aspects of Responsible AI.

Greetings from “downstairs” :)



Outline

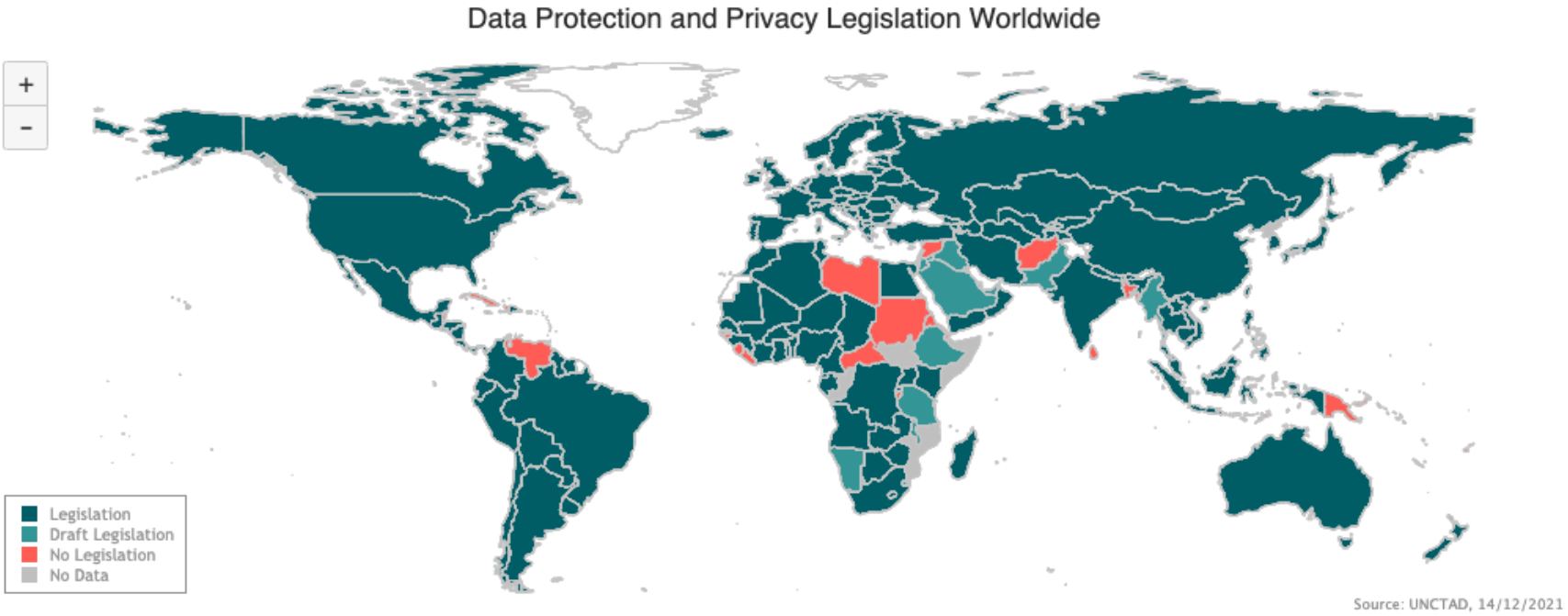
1. Background and Motivation

2. Current Privacy Policy Research Landscape
   - Content Analysis (PP Descriptions - Software Behaviours)
   - Compliance Checking (PP Descriptions - Law/Reg Requirements)
   - Transparency and Readability of PP and Privacy Notices

3. My Research Projects
   - An empirical study of Online Automated Privacy Policy Generators
   - Contextual Privacy Policy for Mobile applications

Privacy issues are making headlines everyday!

Privacy Laws and Regulations



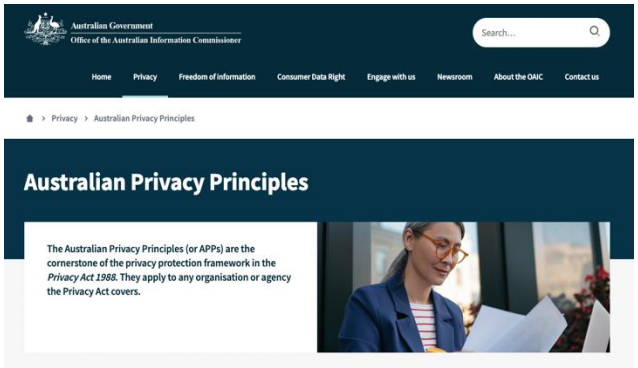
According UNCTD, 137 out of 194 countries had put in place legislation to secure the protection of data and privacy.

The Privacy Policy is essential and critical!

Software Applications

Privacy Policies

Privacy Laws



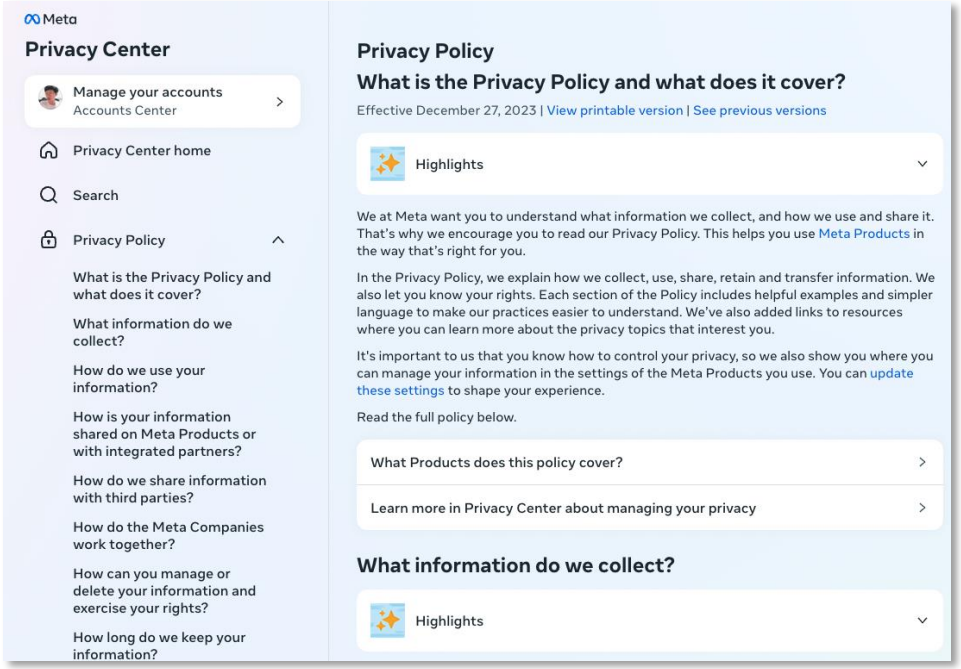
An APP entity must have a clearly expressed and up to date policy (the APP **privacy policy**) about the management of personal information by the entity [APP 1.3]

In re Google Assistant Privacy Litigation
457 F. Supp. 3d 797 - Dist. Court, ND California, 2020 - Google Scholar
… with our **Privacy Policy** and other appropriate **confidentiality** and security … **Privacy Policy** Litig., 58 F. Supp … 2012) (finding no invasion of **privacy** based on Defendants' disclosure of each …
☆ Save 99 Cite Cited by 64 How cited All 2 versions

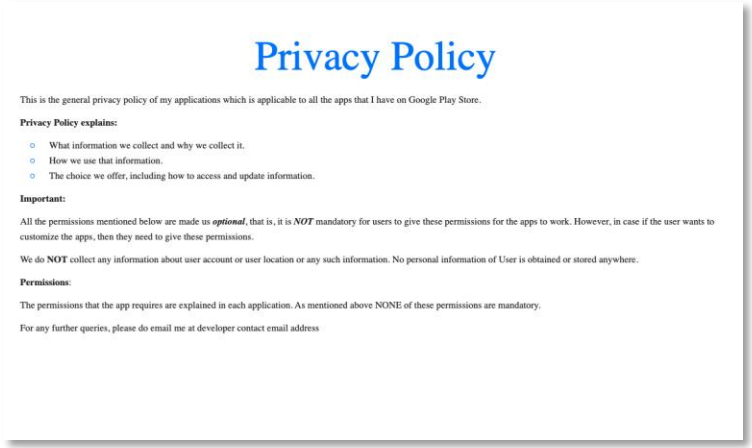
In re Facebook, Inc. Internet Tracking Litigation
956 F. 3d 589 - Court of Appeals, 9th Circuit, 2020 - Google Scholar
… First, the December 2010 **Privacy Policy** does not contain any agreement that Facebook would not track … [11] Second, and more generally, the **Privacy** and Data Use **Policies** do not …
☆ Save 99 Cite Cited by 267 How cited All 2 versions

Kauders v. Uber Technologies, Inc.
486 Mass. 557, 159 NE 3d 1033 - Mass: Supreme Judicial Court, 2021 - Google Scholar
… general principles of state contract law as **rules** of decision … the link to the terms and conditions and the **privacy policy** … question then becomes whether this type of **notice** was reasonable …
☆ Save 99 Cite Cited by 54 How cited All 2 versions

Examples of privacy policies



Facebook/Meta
> 20,000 words



Privacy Policy

This is the general privacy policy of my applications which is applicable to all the apps that I have on Google Play Store.

Privacy Policy explains:

- What information we collect and why we collect it.
- How we use that information.
- The choice we offer, including how to access and update information.

Important:

All the permissions mentioned below are made us ***optional***, that is, it is ***NOT*** mandatory for users to give these permissions for the apps to work. However, in case if the user wants to customize the apps, then they need to give these permissions.

We do **NOT** collect any information about user account or user location or any such information. No personal information of User is obtained or stored anywhere.

Permissions:

The permissions that the app requires are explained in each application. As mentioned above NONE of these permissions are mandatory.

For any further queries, please do email me at developer contact email address

Easy Communication
1k installs, 156 words

People do not read privacy policies!

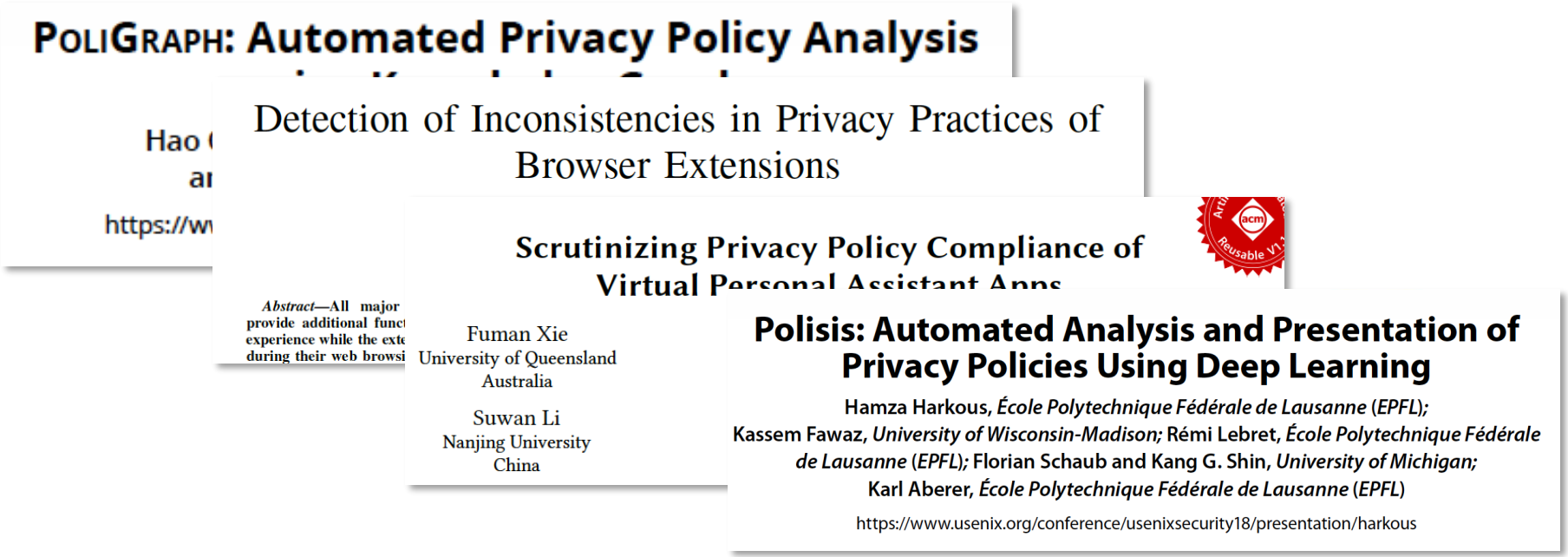
- Privacy policies are very lengthy and detailed. The average length for popular app is about **4,000 words**.
- About **74% users don't read** privacy policy. For those who read it, the average reading time is 73 seconds [1].

The Hobbit: An Unexpected Journey (2012)

Thus, **user-centric** privacy notice and the **usable privacy** technology are pressingly needed.

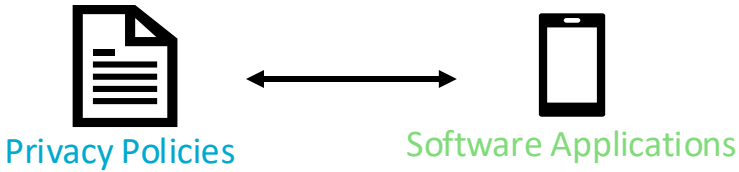
[1] Jonathan A. Obar. 2016. The Biggest Lie on the Internet: Ignoring the Privacy Policies and Terms of Service Policies of Social Networking Services. SSRN Electronic Journal (2016). https://doi.org/10.2139/ssrn.2757465

Privacy Policies are commonly problematic!

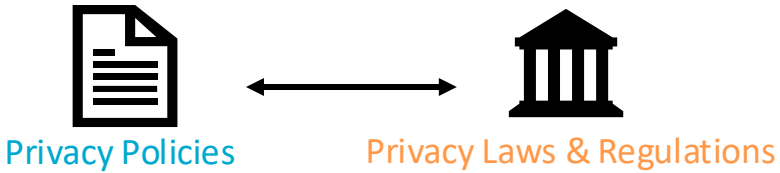


Privacy Policy Research Landscape

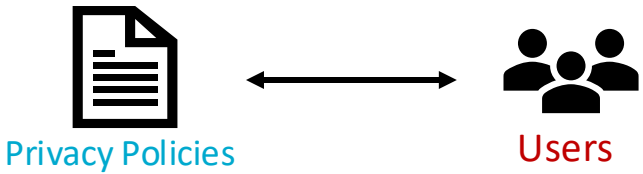
1. Content Analysis (PP Descriptions - Software Behaviours):



2. Compliance Checking (PP Descriptions - Law/Reg Requirements)



3. Transparency and Readability of PP and Privacy Notices:



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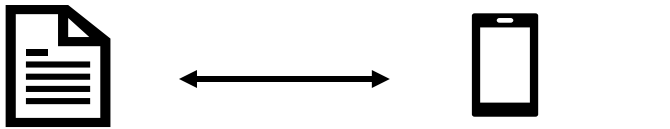

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3. Transparency and Readability of PP and Privacy Notices:

A Typical Framework of PP Content Analysis

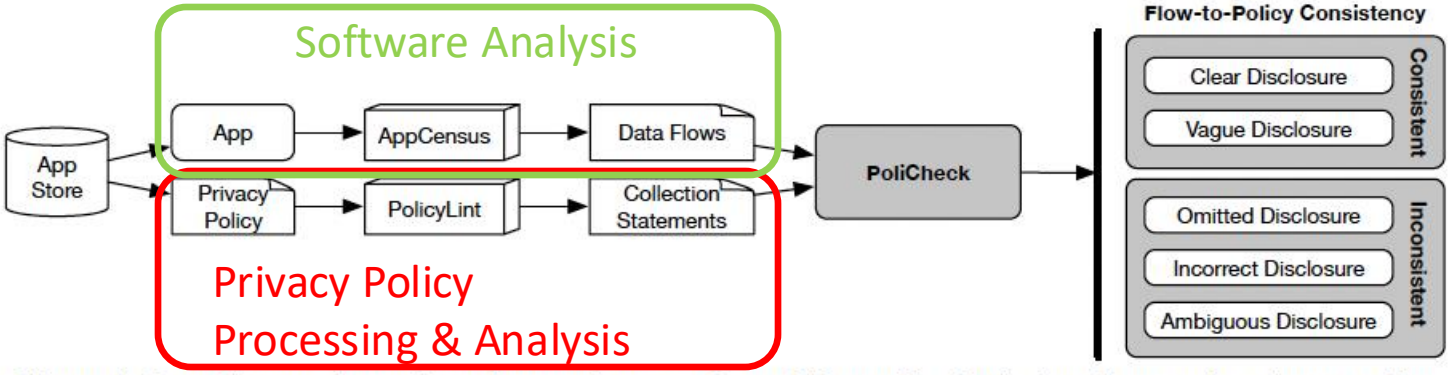


Figure 1: POLICHECK determines the consistency of a mobile application's data flows to its privacy policy.

PolicyLint, Andow et al., USENIX Security 2019

Privacy Policy Content Analysis

Year	Name	Method	Authors	Venue
2016	OPP-115	Machine Learning (LR, SVM, HMM)	Wilson et al.	ACL
2018	Polisis	Deep Learning (CNN + DenseNet)	Harkous et al.	Security
2019	PolicyLint	Sentence-level NLP (NER, DND, etc.)	Andow et al.	Security
2021	PurPliance	Rule-based matching (NER, Pattern Detect)	Bui et al.	CCS
2023	PoliGraph	Rule-based matching (KG)	Cui et al.	Security

A Taxonomy of Privacy Policy Content

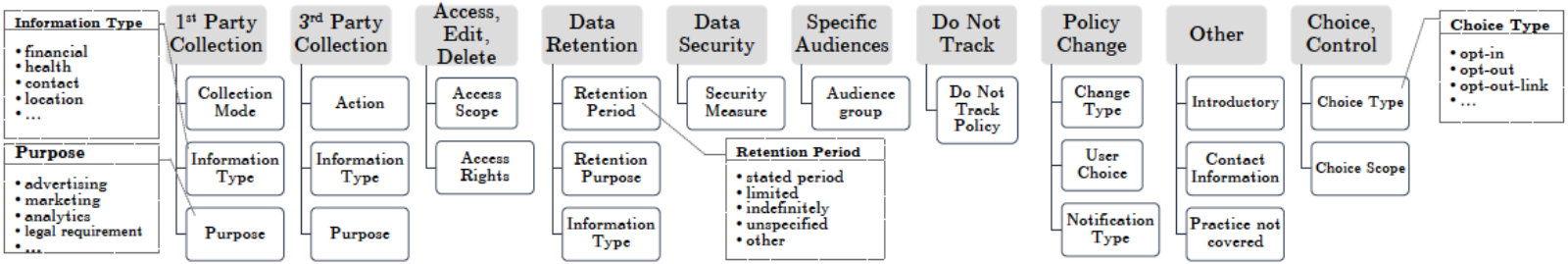


Fig. 3: The privacy taxonomy of Wilson *et al.* [11]. The top level of the hierarchy (shaded blocks) defines high-level privacy categories. The lower level defines a set of privacy attributes, each assuming a set of values. We show examples of values for some of the attributes.

Table 3: Classification *Precision*/*Recall*/*F*1(respectively abbreviated as P/R/F) for every single category, and their *Macro Average* of OPP-115 by Polisis [13], LR, SVM and HMM [6].

	Polisis			LR			SVM			HMM		
Label	**P**	**R**	**F**	**P**	**R**	**F**	**P**	**R**	**F**	**P**	**R**	**F**
1st Party Collection	0.79	0.79	0.79	0.73	0.67	0.70	0.76	0.73	0.75	0.69	0.76	0.72
3rd Party Sharing	0.79	0.80	0.79	0.64	0.63	0.63	0.67	0.73	0.70	0.63	0.61	0.62
User Choice/Control	0.74	0.74	0.74	0.45	0.62	0.52	0.65	0.58	0.61	0.47	0.33	0.39
Access, Edit, Deletion	0.89	0.75	0.80	0.47	0.71	0.57	0.67	0.56	0.61	0.48	0.42	0.45
Data Retention	0.83	0.66	0.71	0.10	0.35	0.16	0.12	0.12	0.12	0.08	0.12	0.09
Data Security	0.88	0.83	0.85	0.48	0.75	0.59	0.66	0.67	0.67	0.67	0.53	0.59
Policy Change	0.95	0.84	0.88	0.59	0.83	0.69	0.66	0.88	0.75	0.52	0.68	0.59
Do Not Track	0.94	0.97	0.95	0.45	1.0	0.62	1.0	1.0	1.0	0.45	0.40	0.41
Specific Audiences	0.96	0.94	0.95	0.49	0.69	0.57	0.70	0.70	0.70	0.67	0.66	0.66
Marco Average	0.85	0.79	0.81	0.49	0.69	0.56	0.65	0.66	0.66	0.52	0.50	0.50

Non-LLM Models

Table 1: Classification *Precision*/*Recall*/*F*1(respectively abbreviated as P/R/F) for every single category, their *Macro Average*, and the total *Accuracy* of OPP-115 by ChatGPT, GPT4 and Claude2.

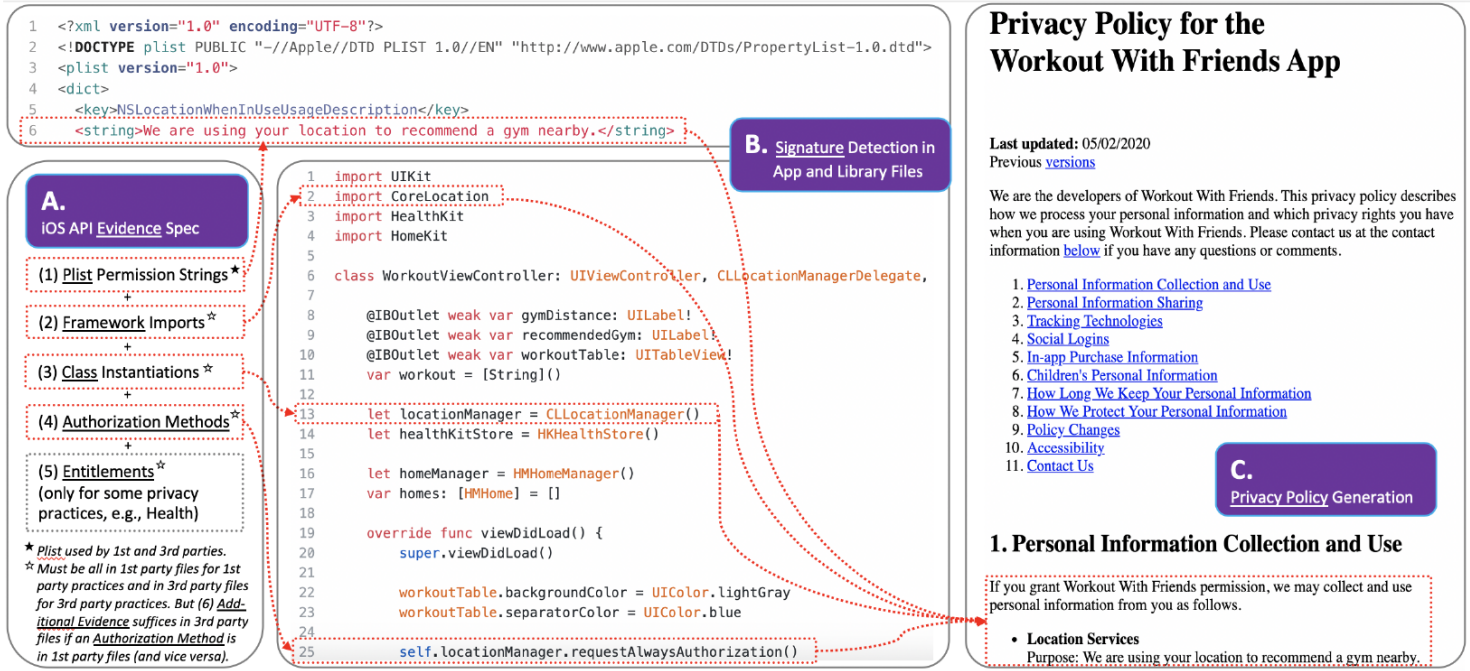
	ChatGPT			GPT4			Claude2		
Label	**P**	**R**	**F**	**P**	**R**	**F**	**P**	**R**	**F**
1st Party Collection	0.94	0.90	0.92	0.98	0.97	0.97	0.99	0.65	0.78
3rd Party Sharing	0.92	0.90	0.91	0.97	0.95	0.96	0.69	0.98	0.81
User Choice/Control	0.92	0.90	0.91	0.92	0.98	0.95	0.77	0.63	0.69
Access, Edit, Deletion	0.89	0.99	0.94	0.92	0.99	0.96	0.87	0.84	0.85
Data Retention	0.93	0.96	0.95	1.00	0.81	0.89	1.00	0.96	0.98
Data Security	0.79	0.96	0.86	0.98	0.97	0.97	0.84	0.85	0.85
Policy Change	0.96	0.99	0.98	1.00	0.99	1.00	0.94	0.68	0.79
Do Not Track	0.91	1.00	0.95	1.00	1.00	1.00	1.00	0.35	0.52
Specific Audiences	1.00	0.92	0.96	1.00	0.95	0.97	0.93	0.79	0.86
Other	0.92	1.00	0.96	0.99	1.00	0.99	0.96	1.00	0.98
Accuracy			0.92			0.97			0.81
Marco Average	0.92	0.95	0.93	0.98	0.96	0.97	0.90	0.77	0.81

LLMs

Software (mobile apps) Privacy Behaviour Analysis

Year	Name	Method/Intro	Authors	Venue
2020	PoliCheck	Android apps entity-sensitive policy and data-flow Analysis	Andow et al.	Security
2021	PrivacyFlash Pro	iOS apps data-flow to disclosure	Zimmeck et al	NDSS
2023	Lalaine	iOS apps data-flow to privacy-label	Xiao et al.	Security
2024	Matcha	Android app IDE In-IDE data/permission usage to privacy-label	Li et al. 2024	IMWUT

Content Analysis tools



PrivacyFlash Pro: Automating Privacy Policy Generation for Mobile Apps, Zimmeck et al., NDSS 2021

Take-home Messages

1. With the development of deep learning-based NLP (e.g., Transformers, GPTs), more researchers choose to embrace rule-based/pattern matching NLP methods.

2. Accurate mobile app behaviour extraction (Static Analysis + Dynamic Analysis) is challenging!

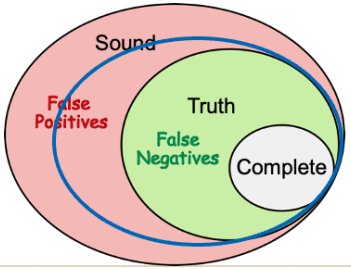
3. Current studies commonly focus on data entities alignment, neglecting the fine-grained data purposes.

No. Privacy policies	50
No. Segments	3,940
No. Words	103,860
Avg. Segments	79
Avg. Words	2,120

2020

No. Privacy policies	50
No. Segments	7,357
No. Words	194,974
Avg. Segments	147
Avg. Words	3,979

2023



Rice's Theorem

Privacy Policy Research Landscape

1. Content Analysis (PP Descriptions - Software Behaviours):

2. Compliance Checking (PP Descriptions - Law/Reg Requirements)

3. Transparency and Readability of PP and Privacy Notices:

Requirement Extraction from Laws/Regs

CCPA Requirement	iubenda May'20	iubenda Jan'21
Disclosure of right to request how personal information is collected, used, sold, disclosed for a business purpose, and shared [CCPA §1798.130(a)(5)(A), 1798.110(a), 1798.115(a), Regs §999.308(c)(1)(a)]	✓	✓
Disclosure of right to request deletion of personal information [CCPA §1798.105(b), 1798.130(a)(5)(A), Regs §999.308(c)(2)(a)]	✓	✓
Disclosure of whether personal information is sold and right to opt-out of sale [Regs §999.308(c)(3)(a), 999.308(c)(3)(b), 999.306]	✓	✓
Disclosure of right to not be discriminated against when requesting any rights [CCPA §1798.130(a)(5)(A), 1798.125(a), Regs §999.308(c)(4)(a)]	✗	✗
Instructions for submitting requests and link to online form or portal if offered [Regs §999.308(c)(1)(b), 999.308(c)(2)(b), 999.308(c)(2)(c)]	✓	✓
Instructions for authorized agents to make requests [Regs §999.308(c)(5)(a)]	✓	✓
Description of the process used to verify requests [Regs §999.308(c)(1)(c)]	✓	✓
List of categories of personal information collected in preceding 12 months [CCPA §1798.130(a)(5)(B), 1798.110(c), Regs §999.308(c)(1)(d)]	✓	✓
List of categories of personal information sold in preceding 12 months [CCPA §1798.130(a)(5)(C), 1798.115(c)(1), Regs §999.308(c)(1)(g)(1)]	✓	✓
List of categories of personal information disclosed for business purpose in preceding 12 months [CCPA §1798.130(a)(5)(C), 1798.115(c)(2), Regs §999.308(c)(1)(g)(1)]	✗	✗
For each personal information category, categories of third parties to whom information was disclosed or sold [Regs §999.308(c)(1)(g)(2)]	✓	✓
Categories of sources from which personal information is collected [Regs §999.308(c)(1)(e)]	✓	✓
Business or commercial purpose for collecting or selling personal information [Regs §999.308(c)(1)(f)]	✓	✓
Whether the business has actual knowledge that it sells personal information of minors under 16 years of age and special process [Regs §999.308(c)(1)(g)(3), 999.308(c)(9)]	✓	✓
Contact information for questions or concerns [Regs §999.308(c)(6)(a)]	✓	✓
Date policy was last updated [Regs §999.308(c)(7)]	✓	✓
Special requirements for businesses buying, receiving, selling, or sharing personal information of 10,000,000 or more consumers in a calendar year [Regs §999.308(c)(8), 999.317(g)(1)]	✗	✗
For online notices, follow generally recognized industry standards, such as the W3C Web Content Accessibility Guidelines, version 2.1 of June 5, 2018 [Regs §999.308(a)(2)(d)]	✗	✗

TABLE II: CCPA privacy policy requirements and generators' compliance.

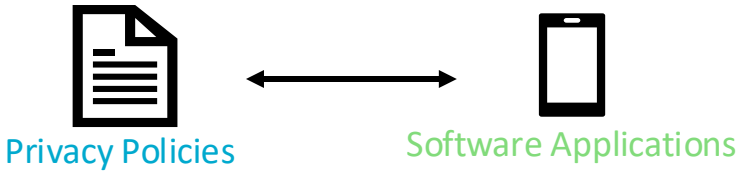
(1) *Collect Personal Information*: Collect data subjects' information which can identify their personal IDs. `[GDPR Art 13.1]`
(2) *Data Retention Period*: Retention period of personal information. `[GDPR Art 13.2(a)]`
(3) *Data Processing Purposes*: The purposes of processing personal data. `[GDPR Art 13.1(c)]`
(4) *Contact Details*: The contact details of the controller or the Data Protection Officer. `[GDPR Art 13.1(a)(b)]`
(5) *Right to Access*: The right (of the data subject) to request from the controller to access their personal information. `[GDPR Art 13.2(b)]`
(6) *Right to Rectify or Erase*: The right (of the data subject) to request from the controller to rectify or erase of their personal information. `[GDPR Art 13.2(b)]`
(7) *Right to Restrict of Processing*: The right (of the data subject) to request from the controller to restrict processing concerning the data subject. `[GDPR Art 13.2(b)]`
(8) *Right to Object to Processing*: The right (of the data subject) to request from the controller to object to processing. `[GDPR Art 13.2(b)]`
(9) *Right to Data Portability*: The right (of the data subject) to receive and transmit his/her personal data to another controller. `[GDPR Art 13.2(b)]`
(10) *Right to Lodge a Complaint*: The right (of the data subject) to lodge a complaint with a supervisory authority. `[GDPR Art 13.2(d)]`

PrivacyFlash Pro: Automating Privacy Policy Generation for Mobile Apps, Zimmeck et al., NDSS 2021

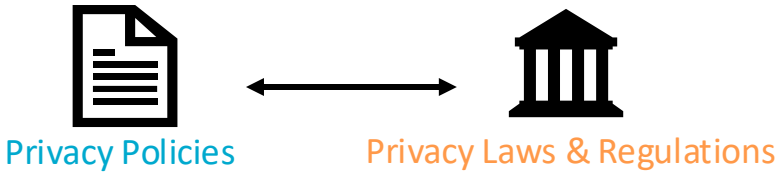
Have You been Properly Notified? Automatic Compliance Analysis of Privacy Policy Text with GDPR Article 13, Liu et al., WWW 2021

Privacy Policy Research Landscape

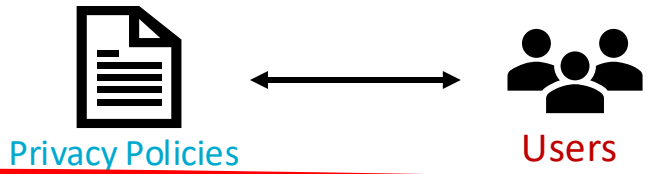
1. Content Analysis (PP Descriptions - Software Behaviours):



2. Compliance Checking (PP Descriptions - Law/Reg Requirements)



3. Transparency and Readability of PP and Privacy Notices:



Motivation: transparent and readability of PPs

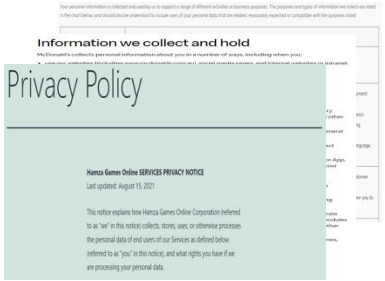
1. Requirements in laws/regulations
    1. EU General Data Protection Regulations (GDPR)
    2. California Consumer Privacy Act of 2018 (CCPA)
    3. Australian Privacy Principles (APP): have *a clearly expressed* and up-to-date APP Privacy Policy about how the entity manages personal information.

2. Users' and consumers' practical need

    According to a survey conducted by The Washington Times, 36% of interviewees **never** read privacy policies, and 38% of interviewees sometimes read privacy policies.

Development History

1. Privacy Policy



2. Privacy Icons

3. Platform for Privacy Preference

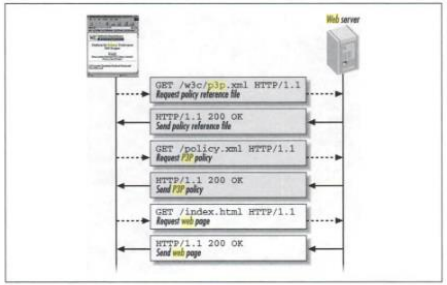
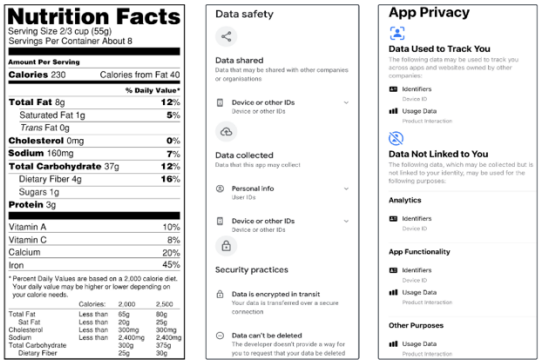
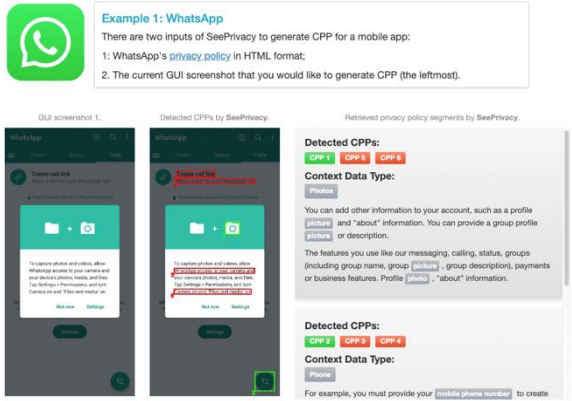


Figure 1-1. The basic protocol for fetching a P3P policy

4. Privacy Labels



5. Contextual Privacy Policy



Privacy Policy Research Landscape: My research

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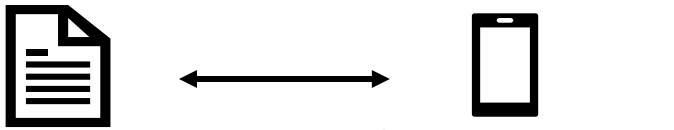

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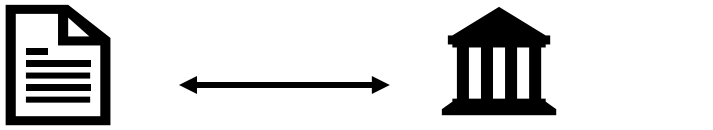
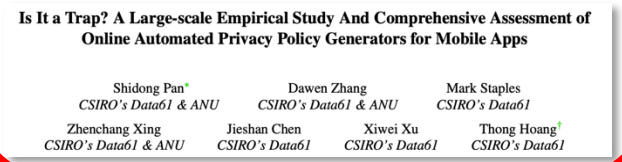


3. Transparency and Readability of PP and Privacy Notices:

An Empirical Study of Automated {Privacy Policy Generators}

[Topic]: Content Analysis + Compliance Analysis

[Venue]: USNEIX Security 2024


Is It a Trap? A Large-scale Empirical Study And Comprehensive Assessment of Online Automated Privacy Policy Generators for Mobile Apps

Shidong Pan* CSIRO's Data61 & ANU
Dawen Zhang CSIRO's Data61 & ANU
Mark Staples CSIRO's Data61
Zhenchang Xing CSIRO's Data61 & ANU
Jieshan Chen CSIRO's Data61
Xiwei Xu CSIRO's Data61
Thong Hoang† CSIRO's Data61

{Contextual Privacy Policy} for Mobile Apps

[Topic]: Transparency and Readability of Privacy Policies

[Venue]: USNEIX Security 2024


A NEW HOPE: Contextual Privacy Policies for Mobile Applications and An Approach Toward Automated Generation

Shidong Pan[1,2†], Zhen Tao[1,2], Thong Hoang[2†], Dawen Zhang[1,2], Tianshi Li[3], Zhenchang Xing[1,2], Xiwei Xu[2], Mark Staples[2], Thierry Rakotoarivelo[2], and David Lo[4]

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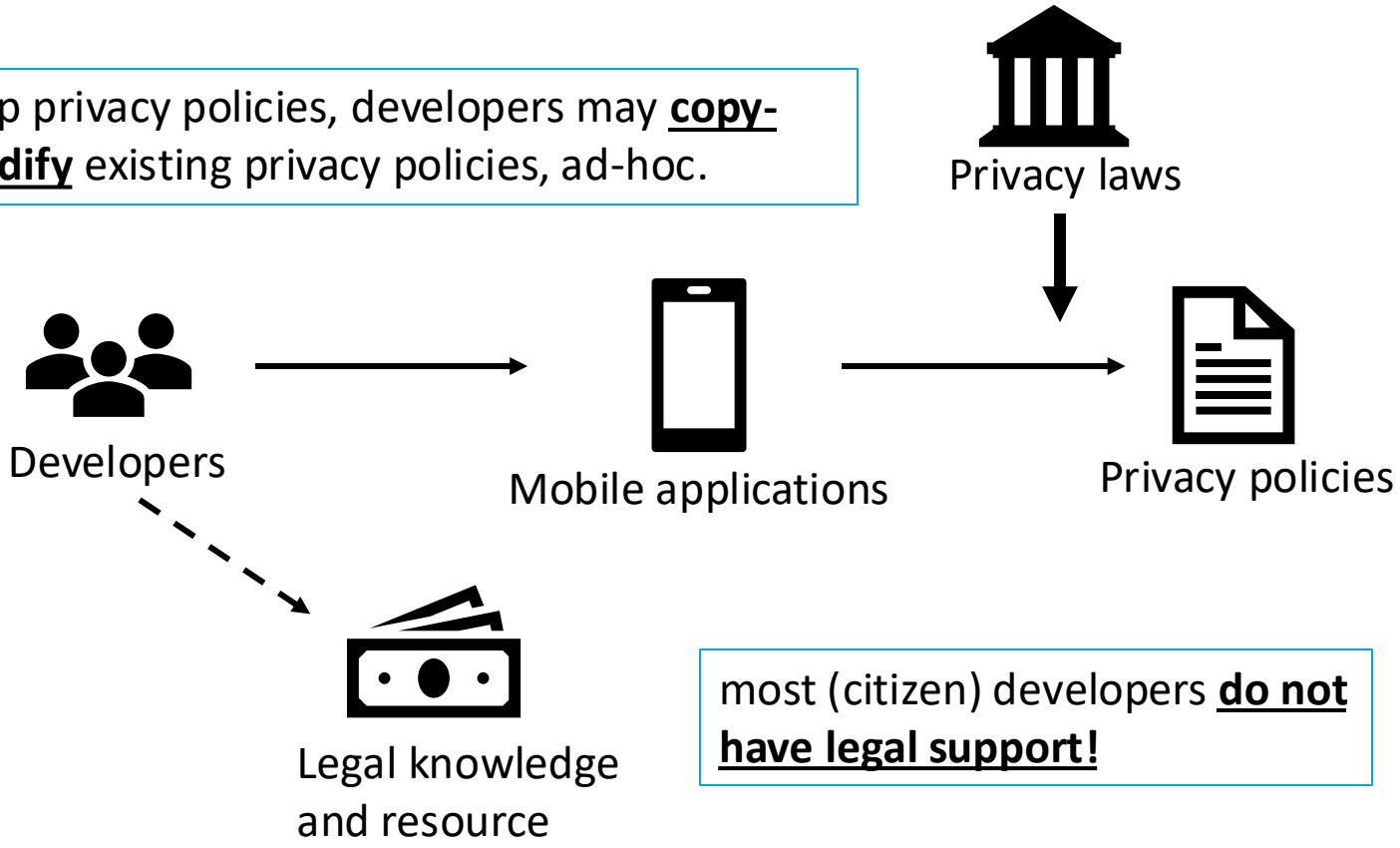
How do those problematic privacy policies be crafted?

To develop privacy policies, developers may **copy-paste-modify** existing privacy policies, ad-hoc.

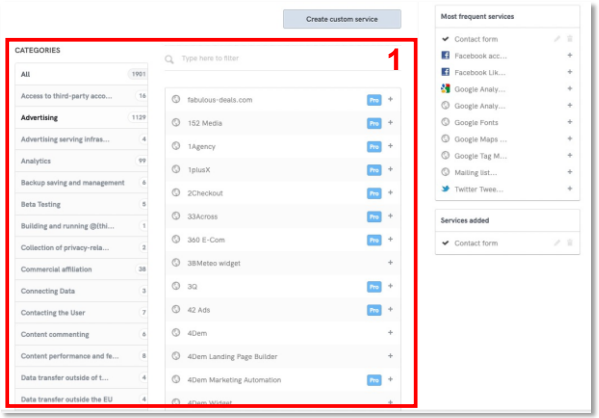


most (citizen) developers **do not have legal support!**

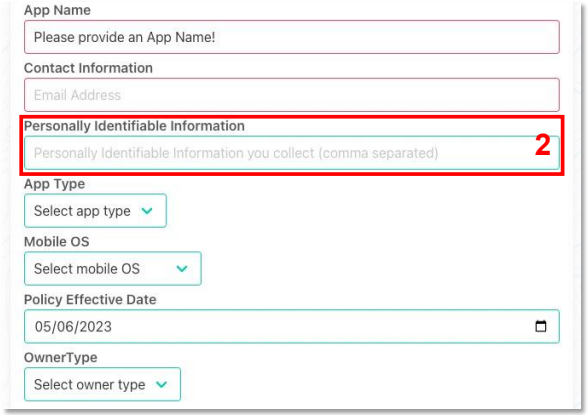
Online Automated Privacy Policy Generator (APPG) as the Solution

🔍 Online **Automated Privacy Policy Generators** can provide more automated and systematic solutions for developers, rather than through ad-hoc copy-paste-modify.

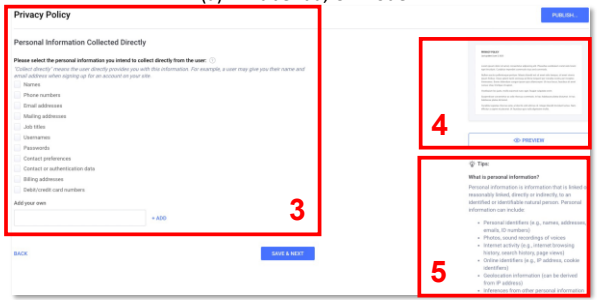
However, their **quality and other characteristics** can vary and are not yet deeply understood.



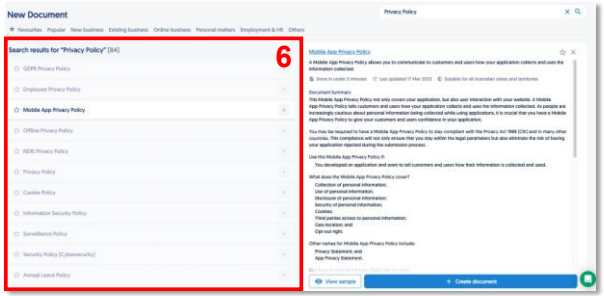
(a) #1 Iubenda, UI-mode



(b) #2 App Privacy Policy Generator, questionnaire-mode



(c) #3 Termly, questionnaire-mode



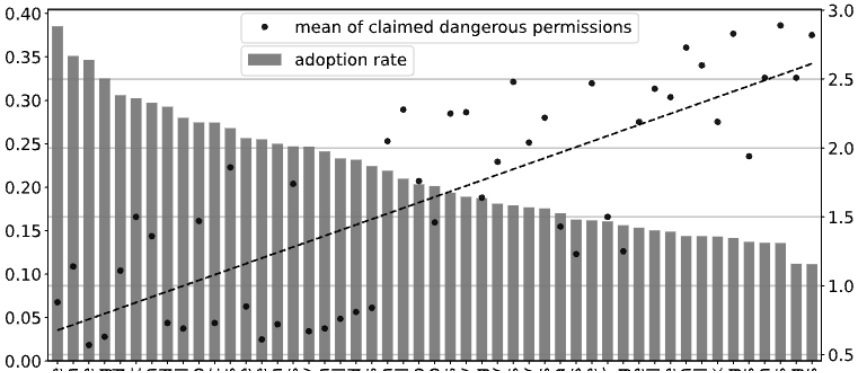
(d) #10 Lawpath, document-mode

The **Prevalence** of APPGs in Market

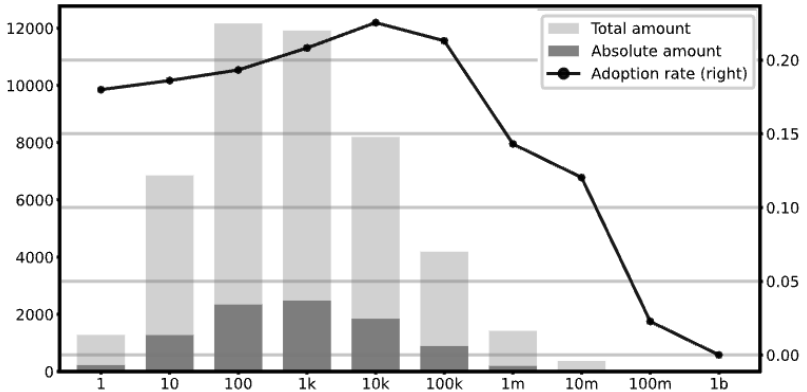
Table 4: Summary of market use of different APPGs.

Method	Market Occupancy
Fingerprint Keyword Searching	6.6% (3,066)
Document Similarity Comparison	18.1% (8,425)
Intersection	4.4% (2,042)
Union (Total)	**20.1% (9,332)**

The market occupancy ratio of 10 examined APPGs is around **20.1%!**



App Category



App Downloads

The **Compliance** of APPGs against Regulations

Table 6: Tallies of the APPGs' compliance against legal requirements in privacy regulations. The individual requirements of LGPD are shown in Table 5. "N.R." stands for "no record". The enforcement date of LGPD is September 2020.

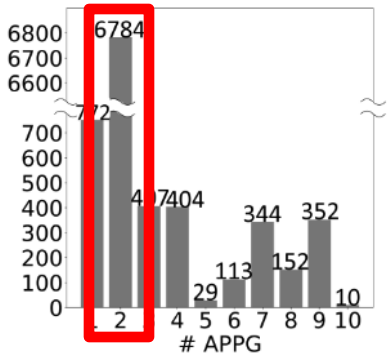
#	GDPR			CCPA			LGPD
	May'20	Jan'21	May'22	May'20	Jan'21	May'22	May'22
1	8/8	8/8	8/8	14/18	14/18	14/18	8/8
2	N.R.	N.R.	3/8	N.R.	N.R.	3/18	3/8
3	8/8	8/8	8/8	3/18	15/18	15/18	6/8
4	8/8	8/8	8/8	5/18	16/18	16/18	6/8
5	N.R.	N.R.	0/8	N.R.	N.R.	2/18	1/8
6	N.R.	N.R.	0/8	N.R.	N.R.	2/18	1/8
7	8/8	8/8	8/8	5/18	16/18	16/18	6/8
8	N.R.	N.R.	8/8	N.R.	N.R.	11/18	5/8
9	8/8	8/8	8/8	5/18	16/18	16/18	6/8
10	N.R.	N.R.	2/8	N.R.	N.R.	2/18	4/8

Table 7: The disclosure existence of seven fundamental data rights. Numbers in the first row indicate APPGs as per Table 1, and "Apps" denotes the tallies of disclosure for 12 leading apps.

Data Right	2	3	4	5	6	7	8	9	10	Apps
Right to Know	✗	✓	✓	✗	✗	✓	✓	✓	✓	12/12
Right to Access	✗	✓	✓	✗	✗	✓	✓	✓	✓	12/12
Right to Processing	✗	✓	✓	✗	✗	✓	✓	✓	✗	12/12
Right to Restrict of Processing	✗	✓	✓	✗	✗	✓	✓	✓	✗	12/12
Right to be Forgotten	✗	✓	✓	✗	✗	✓	✓	✓	✓	12/12
Right to Data Transfer	✗	✓	✓	✗	✗	✓	✓	✓	✗	12/12
Right to Lodge a Complaint	✗	✓	✓	✗	✗	✓	✓	✓	✓	12/12

Table 8: The disclosure existence of five highly concerning privacy practices. Numbers in the first row indicate APPGs as per Table 1, and "Apps" denotes the tallies of disclosure for 12 leading apps.

Privacy Practice	1	2	3	4	5	6	7	8	9	10	Apps
Data Encryption	✓	✓	✓	✓	✗	✗	✓	✓	✓	✓	8/12
Government Requests	✓	✗	✓	✓	✗	✗	✓	✓	✓	✗	11/12
Data Breach Notification	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	1/12
Changes Notification	✓	✗	✓	✓	✗	✗	✓	✓	✓	✗	12/12



The #2 App Privacy Policy Generator is the most popular one, boasting a 72.7% adoption rate. Users tend to select **easy-to-use APPGs** even though at the **cost** of a **potentially-higher risk** to breach privacy regulations.

Implications and Findings to Stakeholders

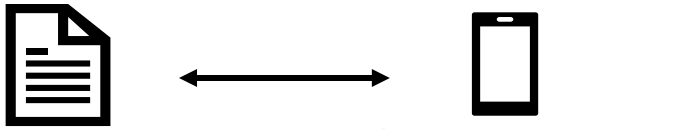
- **App developers/APPG users:** While app developers may benefit from using APPGs to create privacy policies more efficiently, they should be aware of APPGs' latent limitations.

- **APPG providers:** Our analysis suggests APPG providers should work on improving recognised data use, since the majority of APPGs on the market only provide a very limited scope of personal information and device permissions.

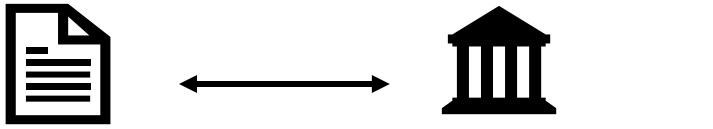
- **Privacy regulators:** Regulators should recognize the importance of this issue and be engage with this emerging market trend.

Privacy Policy Research Landscape: My research

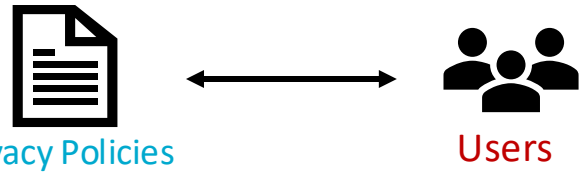
1. Content Analysis (PP Descriptions - Software Behaviours):



2. Compliance Checking (PP Descriptions - Law/Reg Requirements)



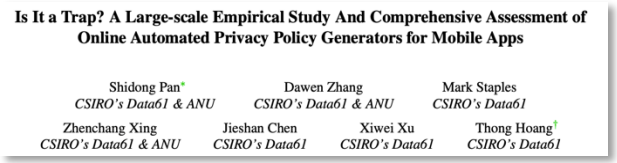
3. Transparency and Readability of PP and Privacy Notices:



An Empirical Study of Automated {Privacy Policy Generators}

[Topic]: Content Analysis + Compliance Analysis

[Venue]: USNEIX Security 2024


Is It a Trap? A Large-scale Empirical Study And Comprehensive Assessment of Online Automated Privacy Policy Generators for Mobile Apps

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Thong Hoang† CSIRO's Data61

{Contextual Privacy Policy} for Mobile Apps

[Topic]: Transparency and Readability of Privacy Policies

[Venue]: USNEIX Security 2024


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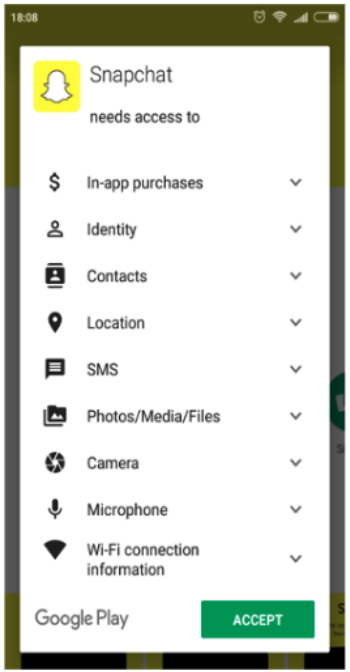
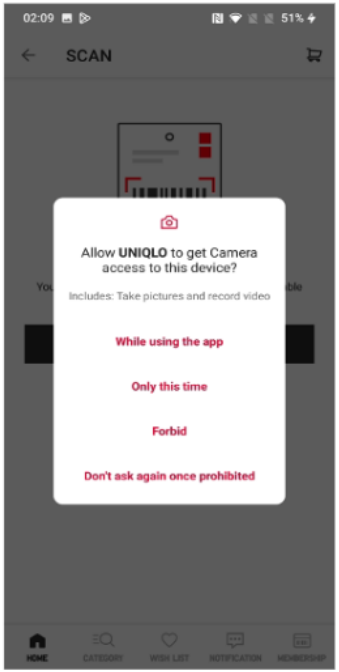
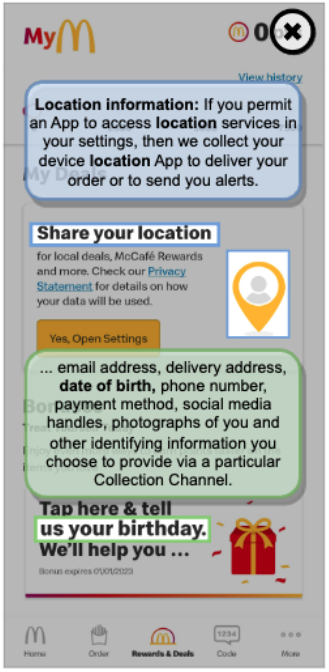
Development of “Just-in-time” Privacy Notices



(a) Install-time



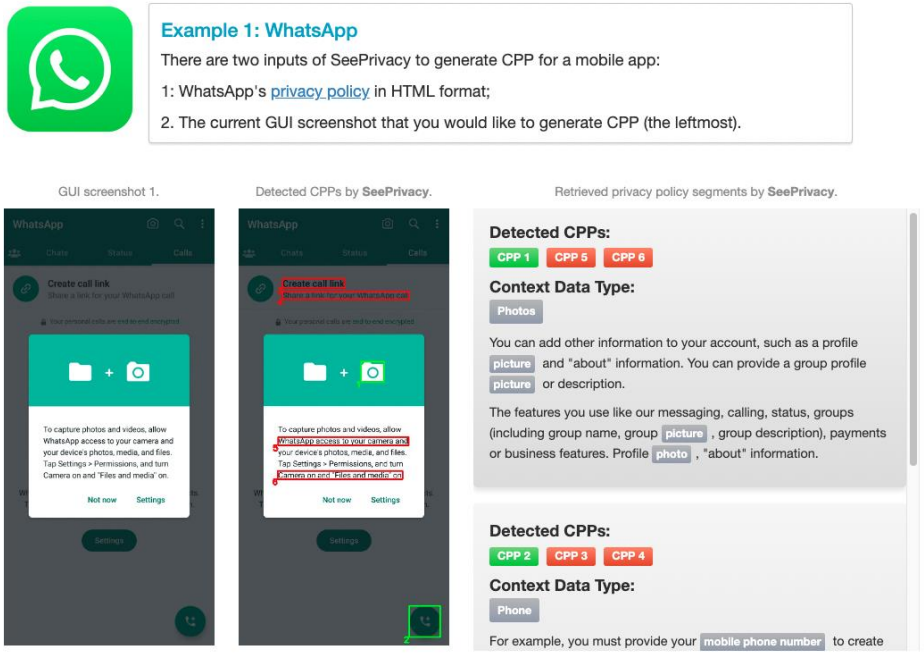
(b) Invoke-time



(c) Context-aware

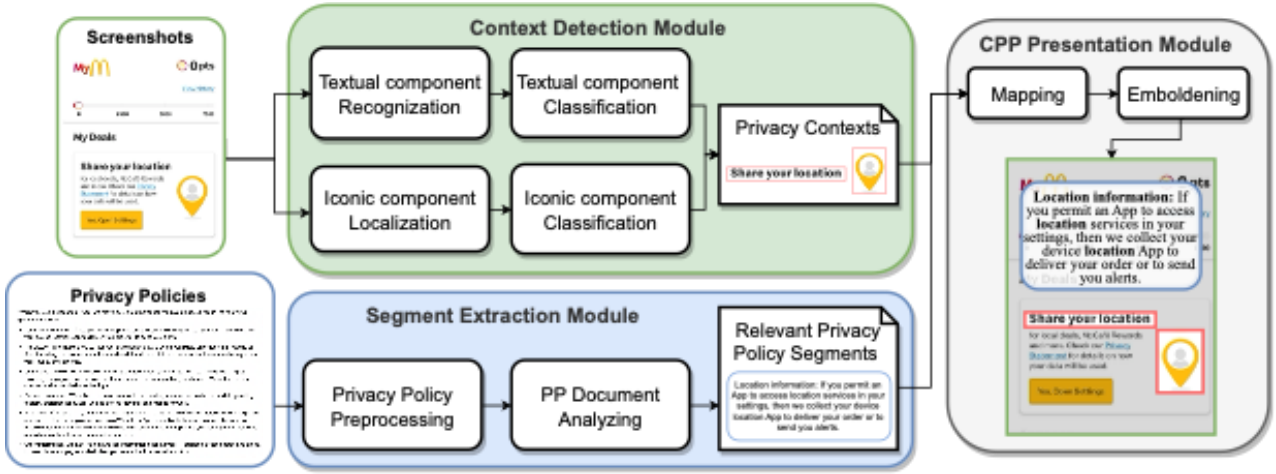
Android 6.0

Contextual Privacy Policy for Mobile Apps



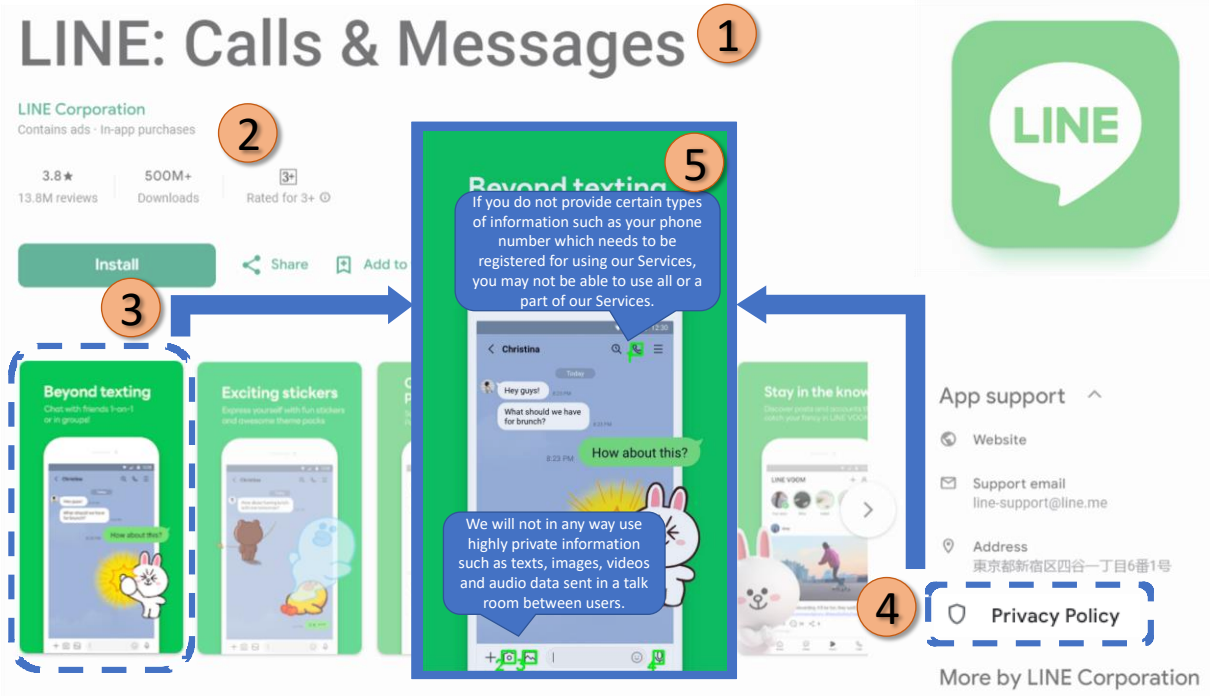
- The aim of **Contextual Privacy Policy** is to fragment **privacy policies** into concise **snippets**, displaying them only within the corresponding contexts within the application's **graphical user interfaces** (GUIs).

Contextual Privacy Policy for Mobile Applications

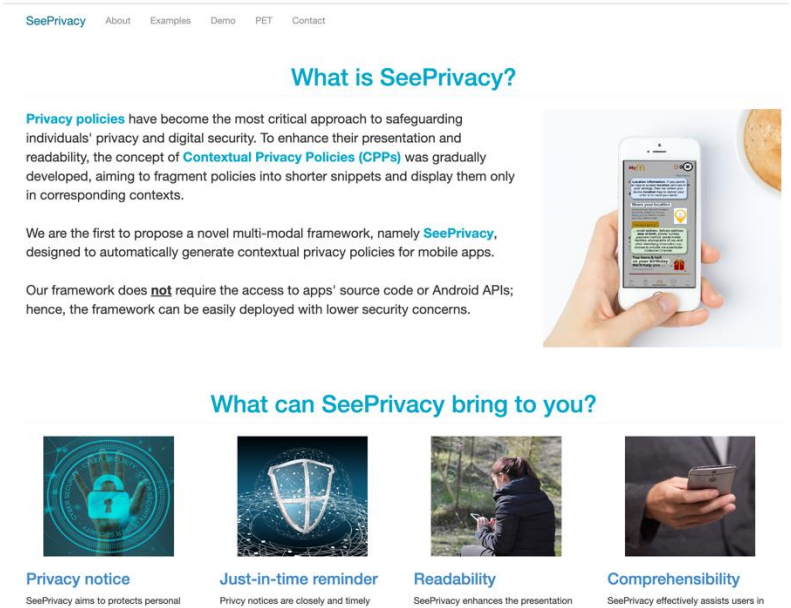


Our multi-modal framework synergistically combines Computer Vision (CV) techniques, pre-trained Large Language Model (LLMs), and Natural Language Processing (NLP) techniques.

An Adoption Scenario: CPP in Market



Implications and Broader Impacts



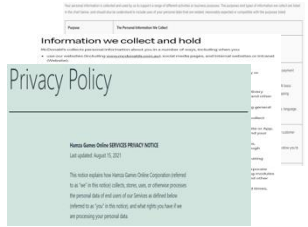
These findings suggest that our framework could serve as a significant tool for **bolstering user interaction with, and understanding of, privacy policies**. Furthermore, our solution has the potential to make privacy notices more **accessible** and **inclusive**, thus appealing to a broader demographic.

Showcase website: https://cpp4app.github.io/

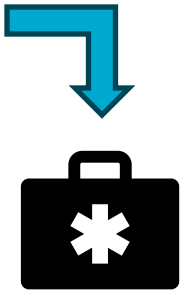
Live demo: https://huggingface.co/Cpp4App/

User-Centric Privacy Enhancing Toolkit (U-PET)

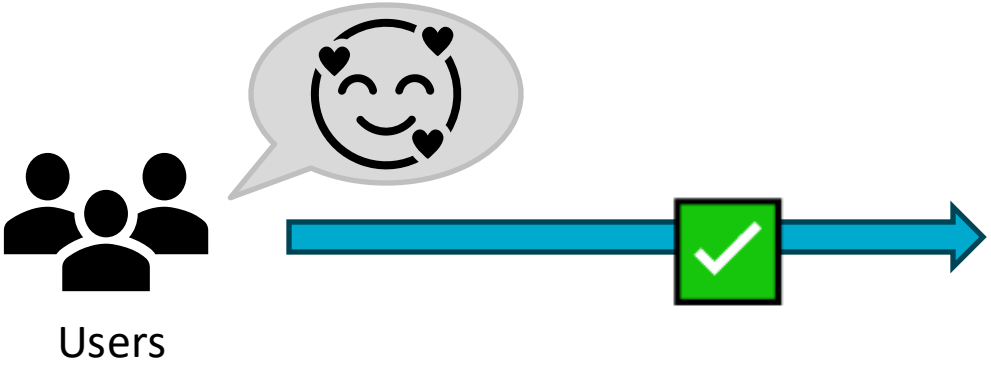
Users



Privacy Information



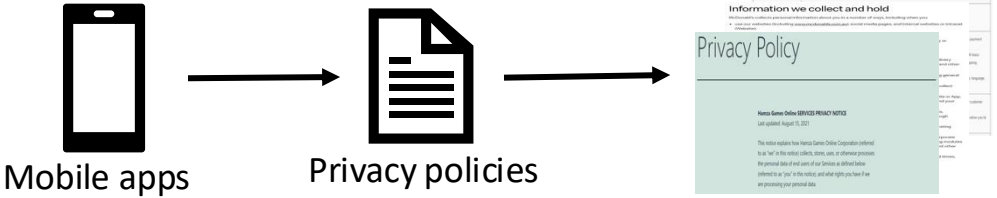
U-PET



Users

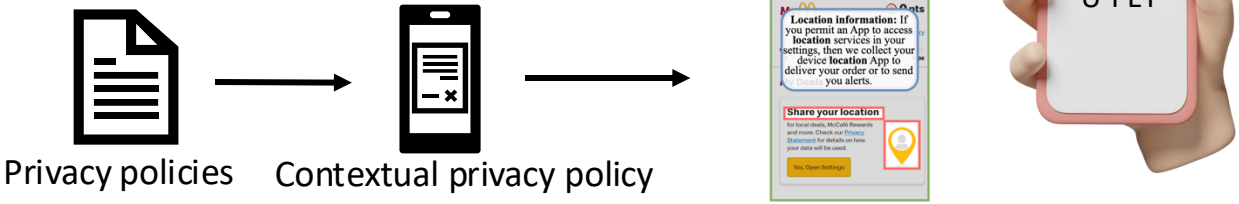
Transparent and Engaging Privacy Information

1. Automated Privacy Policy Generators **(APPGs)**

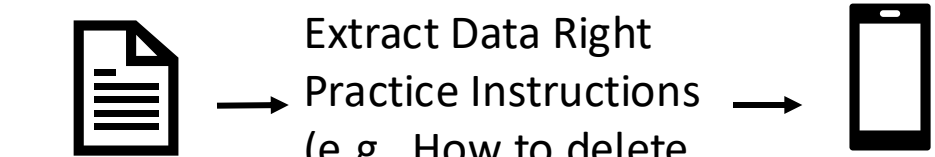


2. Privacy Nutrition Labels From Privacy Policies **(Policy2Label)**

3. Contextual Privacy Policy for Mobile Apps **(Cpp4App)**



4. Data Rights Extraction and Automation in Mobile Apps (**AutoYourRight**)



References

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- Pan, Shidong, Dawen Zhang, Mark Staples, Zhenchang Xing, Jieshan Chen, Xiwei Xu, and Thong Hoang. "Is it a trap? a large-scale empirical study and comprehensive assessment of online automated privacy policy generators for mobile apps." In *33rd USENIX Security Symposium (USENIX Security 24)*, pp. 5681-5698. 2024.
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{Privacy Policy} in Practice: Challenges, Implications, and Solutions

Hope you enjoy the content :)

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University of Edinburgh
March 2024