# **Privee:** An Architecture for Automatically Analyzing Web Privacy Policies Sebastian Zimmeck and Steven M. Bellovin

### **1. Problem: Web Users do not Read Privacy Policies**

Privacy policies on websites are based on the **notice-and-choice** principle. They notify Web users of their privacy choices. However, many users do not read privacy policies or have difficulties understanding them. The resulting **information asymmetry** leaves users uninformed about their privacy choices, can lead to market failure, and calls the notice-and-choice principle into question altogether.

#### 2. Solution: Automatic Analysis of Privacy Policies

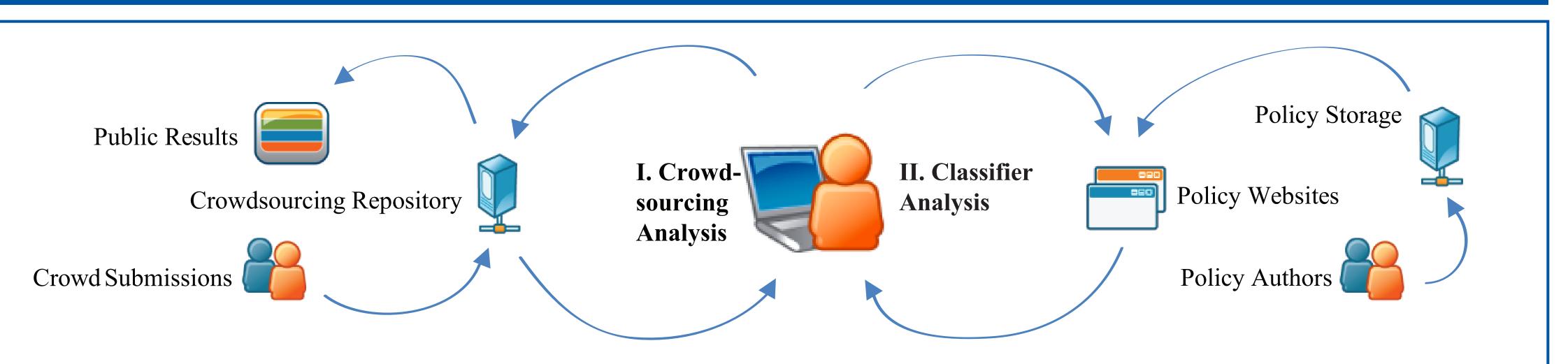
In order to increase privacy transparency we propose **Privee**—a software architecture for analyzing essential policy terms that combines crowdsourcing with rule- and machine learning-based classification techniques.

Privacy Policy : Terms and × → C	about/policies/privacy-policy/	□
	ore	Α
EXPLORE TOPICS V	WATCH VIDEO TV SCHEDULE PBS PROGRAMS DONATE SHOP F	Collection of Personal Info (such as e-mail address)
About PBS V		No Combination with Info from outside Companies
Mission Statement	Privacy Policy	No Advertising Tracking (e.g., no use of Ad Cookies)
PBS Children's Media	, ,	No Disclosure of Personal Info to Advertisers
Station Impact Stories		Personal Info is Archived for Unlimited Time
Support Our Mission 🛛 🗸	PBS is committed to protecting the private information of our web site visitors. From the	Stored and Transmitted Info is not Encrypted
Producing for PBS	pbs.org homepage to more than 150,000 pages of content produced by our affiliates, the	
Editorial & Funding	"pbs.org" domain remains a safe haven. The PBS.org web site adheres to a strict policy for any using the privacy of percentally identifiable information and precenting the integrity.	
Standards	for ensuring the privacy of personally identifiable information and preserving the integrity of this online medium. Here we explain the type of information collected from PBS.org,	Meaning of Grades and Symbols
Terms and Conditions 🛛 🗸	how that information may be used, how you can access or modify that information, and	A = Above Average Overall Privacy □ = Good Privacy Practice B = Average Overall Privacy □ = Neutral Privacy Practice
Website Terms of Use	how that information is protected.	C = Below Average Overall Privacy = Bad Privacy Practice
Privacy Policy		
Copyright Agent	I. WHICH SITES ARE COVERED BY THIS POLICY?	Learn More
Mobile Club Terms of Use	This Privacy Policy applies to PBS.org ("Site"). Please note that our Site may contain	
News 🗸	links to sponsor organizations and PBS Member Stations. We are not responsible for the	
PBS on Social Media	privacy practices of those web sites. We encourage you to review the privacy policy of	
Career Opportunities 🛛 🗸	any organization before submitting your personal information to them.	Recent Activity

Our Privee browser extension (implemented for Google Chrome) performs a classifier analysis checking whether a privacy policy:

- allows **collection** of personal information from users;
- provides **encryption** for information storage or transmission;
- allows ad tracking by means of ad cookies or other trackers;
- provides a **limited retention** period for personal information;
- allows **profiling** of users by combining collected information with information from third parties;
- allows personal information **disclosure to advertisers**.

## **3. The Privee Concept**



When a user requests a privacy policy analysis, the program checks whether analysis results are available at a crowdsourcing repository (to which crowd contributors can submit analysis results of policies). If results are available, they are returned and displayed to the user (I. Crowdsourcing Analysis). If no results are available, the policy text is fetched from the policy website, analyzed by automatic classifiers on the client machine, and the analysis results are displayed to the user (II. Classifier Analysis).

#### 4. Performance and Inter-annotator Agreement

100 -			C • -
		◆ E ◆	
F-1 <sup>1</sup> 80 – LF	R P •		_
60 – • AD			_
0.6	0.7	0.8 0.9	) 1
K.'s a. <sup>1</sup>			
	Base.	F-1	K.'s a.
Overall	<b>68%</b>	90%	0.77
Collection	100%	100%	1
Encryption	52%	98%	0.84
Ad Tracking	64%	97%	0.8
L. Retention	74%	80%	0.68
Profiling	52.%	83%	0.71
Ad Disclosure	66%	60%	0.56

Our classifiers (Naive Bayes and/or rules) have an overall F-1 score of 90% (when compared human annotators to trained in privacy law). The baseline accuracy consists of always selecting the classification that occurred the most for the respective category in our training set.



relates to the same variable to which human interpretations correlate—the ambiguity of natural language. We measured this ambiguity in form of **semantic diversity.** The less ambiguity in the extracted text for the classifier to analyze and in the section for the annotators to read, the fewer misclassifications and disagreements occurred, respectively. 2. Odds ratios and confidence intervals were normalized to Z scores

2014.

ity of annotations we calculated the inter-annotator agreement by Krippendorff's alpha, which indicated for all categories fair or good agreement (except for Ad Disclosure). It is striking that performance (F-1 score) correlates to agreement (Krippendorff's alpha).

To ensure the reliabil-

## **5. Semantic Diversity**

	Extr. Text	Section
ean Sem. D.	1.87	2.08
gnificance (P)	0.02	0.04
dds Ratio $(Z)^2$	2.07	1.51
% C. Int $(Z)^2$	1.12-3.81	1.02-2.22

Our experimental results suggest that classifier performance is inherently limited as it cor-

#### **6.** Reference

Sebastian Zimmeck and Steven M. Bellovin, Privee: An Architecture for Automatically Analyzing Web Privacy Policies, 23rd USENIX Security Symposium, San Diego, CA, USA, August

> COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK