18734: Foundations of Privacy

Course Overview

Anupam Datta
CMU
Fall 2016

Logistics

Course Staff

- Instructor: Anupam Datta
  - Office: B23, 221 (SV)
  - Email: danupam@cmu.edu
  - Office hours: Mon 12-1PM Pacific at SV + Google Hangouts

- TA: Lay Kuan Loh
  - Office: CIC 2221E (Pittsburgh)
  - Office hours: Fri 10:30-11:30am Pacific in CIC 2206 + Skype

Extra office hours on demand

Logistics

- Lectures: Monday & Wednesday, 1:30-3:20 PM Pacific (usually 90 minutes)
- Recitation: Friday 9:30-10:20am Pacific (attend!)
- Web page: http://www.ece.cmu.edu/~ece734/
- Course blackboard (for grades)
- Piazza (for all other communication)
  - Please enroll; you should have received invitation
- Course work and grading:
  - Homework (60%) – 4 x 15%
    - Best 4 of 5 homeworks
  - Course project (30%)
  - Class participation (10%)

Logistics (2)

- Course Project:
  - Teams of 2 (form team by end of week)
  - Project proposal: 1-2 pages + in-class presentation (Sept 26)
  - Deliverable Part I + in-class presentation (Oct 31)
  - Deliverable Part II + Written report: 5-10 pages (Dec 5)
  - In-class presentation (Dec 5, 7)

Logistics (3)

Collaboration policy:

- You are allowed to discuss homework problems and approaches for their solution with other students in the class, but are required to figure out and write out detailed solutions independently and to acknowledge any collaboration or other source

CMU Computing Policy

CMU Academic Integrity Policy

Logistics (4)

Example Violations:

- Submission of work completed or edited in whole or in part by another person.
- Supplying or communicating unauthorized information or materials, including graded work and answer keys from previous course offerings, in any way to another student.
- Use of unauthorized information or materials, including graded work and answer keys from previous course offerings.
- …not exhaustive list

If in doubt, ask me!

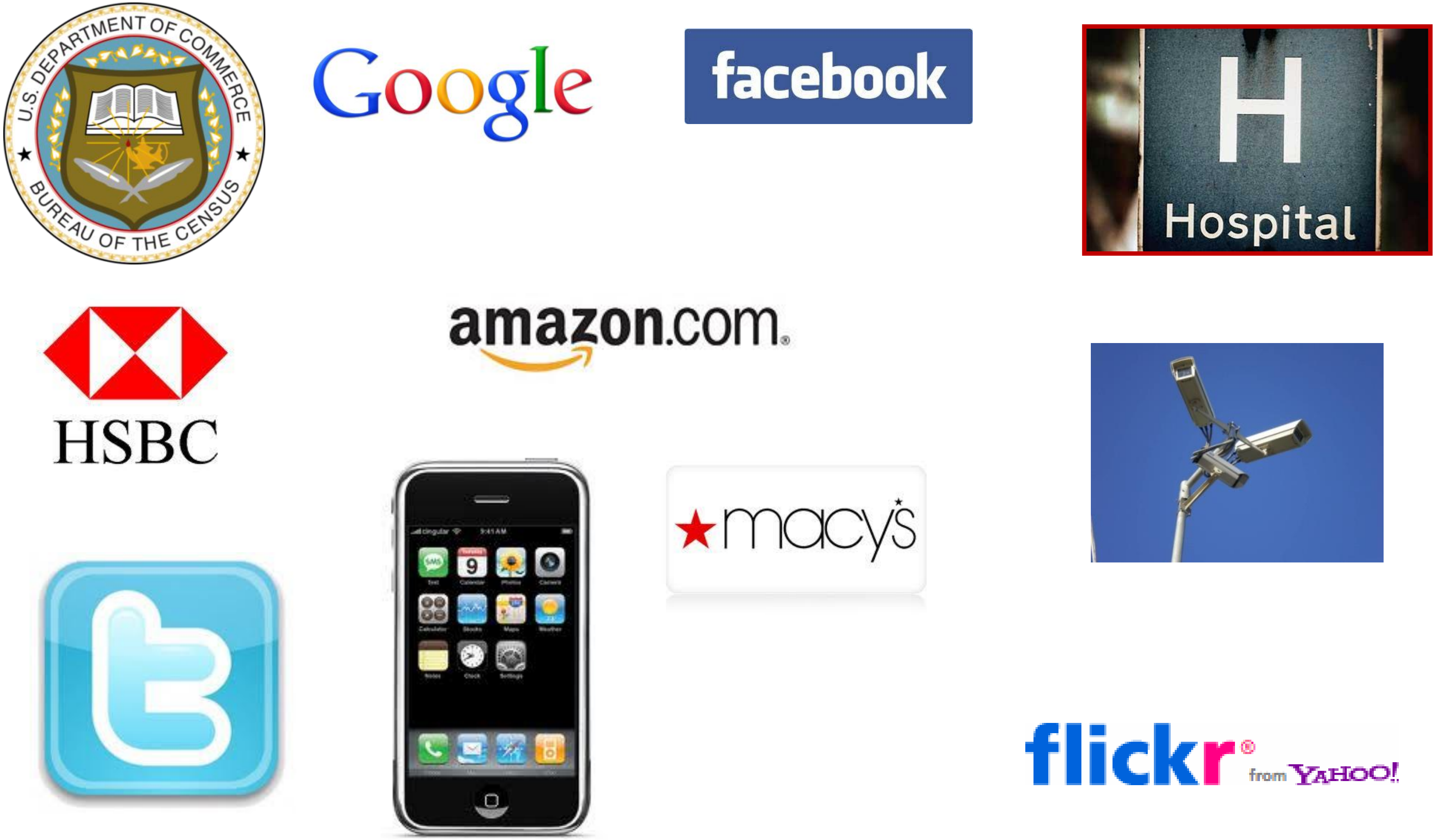
Logistics (6)

- Consent form for video recording lectures

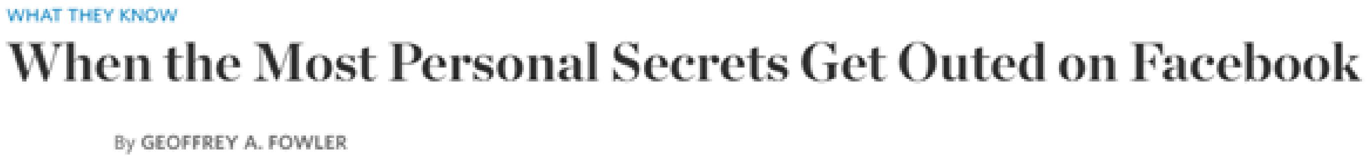
Prerequisites

- An undergraduate course equivalent to 15-251 is required or permission of instructor
- An introductory course in computer security such as 18-487, 18-630, or18-730 is recommended, but not required
- If in doubt, please talk to me after class
- Quick class poll

Personal Information is Everywhere



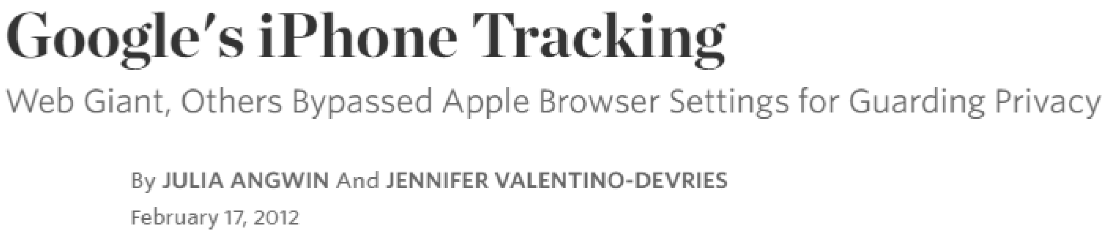
Privacy and Fairness Problems



WHAT THEY KNOW

When the Most Personal Secrets Get Outed on Facebook

By GEOFFREY A. FOWLER

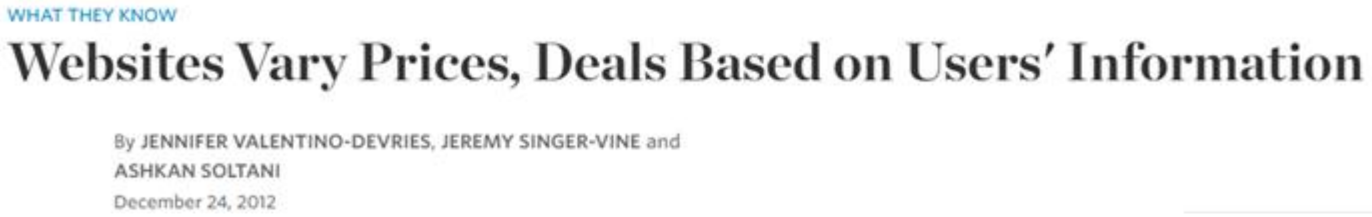


Google's iPhone Tracking

Web Giant, Others Bypassed Apple Browser Settings for Guarding Privacy

By JULIA ANGWIN And JENNIFER VALENTINO-DEVRIES

February 17, 2012

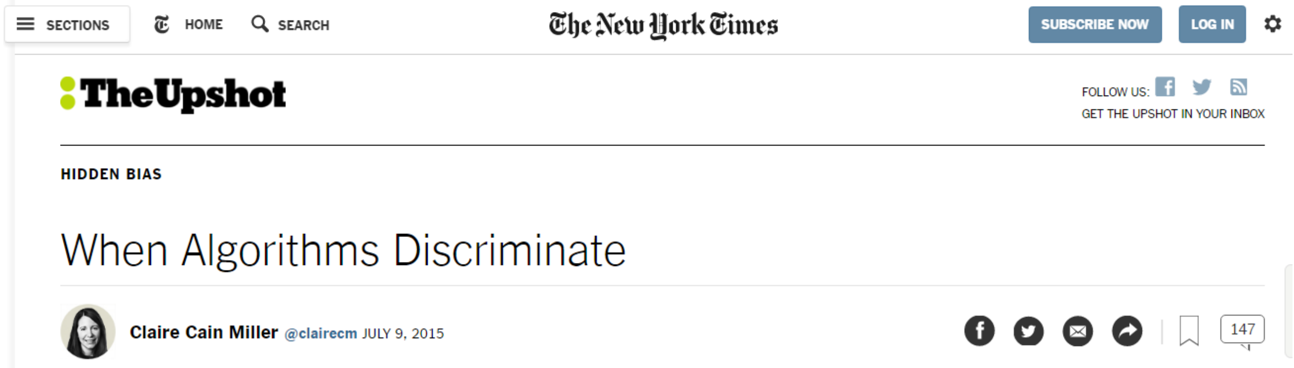


WHAT THEY KNOW

Websites Vary Prices, Deals Based on Users' Information

By JENNIFER VALENTINO-DEVRIES, JEREMY SINGER-VINE and ASHKAN SOLTANI

December 24, 2012

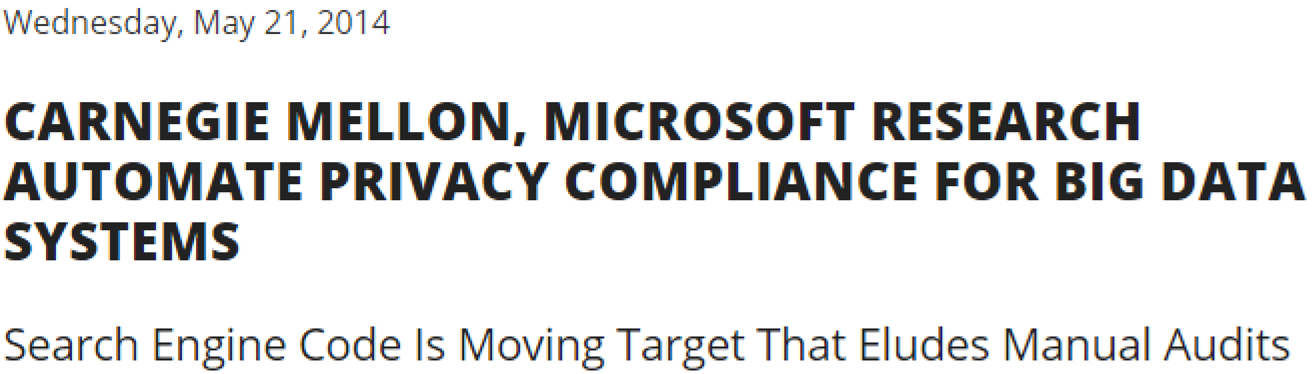


HIDDEN BIAS

When Algorithms Discriminate

Claire Cain Miller @clairecm JULY 9, 2015

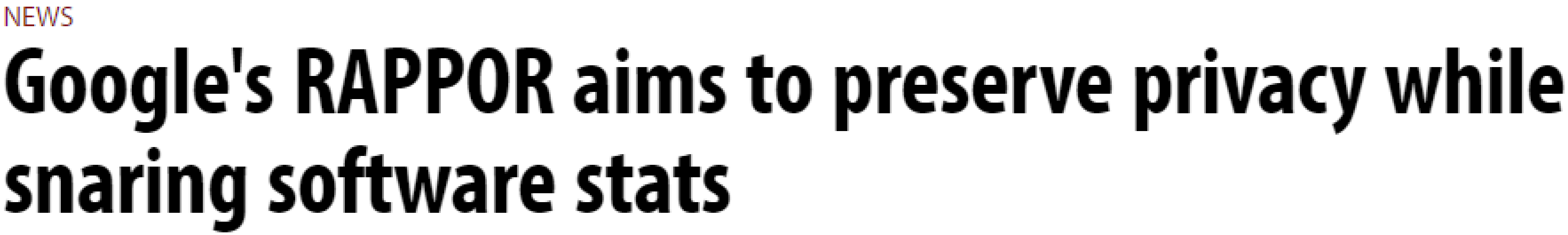
Privacy Solutions



Wednesday, May 21, 2014

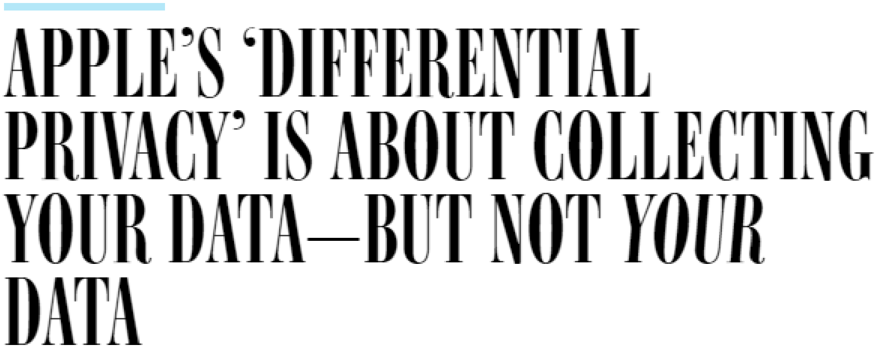
CARNEGIE MELLON, MICROSOFT RESEARCH AUTOMATE PRIVACY COMPLIANCE FOR BIG DATA SYSTEMS

Search Engine Code Is Moving Target That Eludes Manual Audits



NEWS

Google's RAPPOR aims to preserve privacy while snaring software stats



APPLE'S 'DIFFERENTIAL PRIVACY' IS ABOUT COLLECTING YOUR DATA—BUT NOT *YOUR* DATA

Organizing Questions

- What is privacy?
  - From philosophical and legal conceptions to computer science and engineering
  - Inspiration from conceptions, but greater precision often through greater specificity
- How can we protect privacy?
  - Beyond creating laws and institutions
  - Computational mechanisms for privacy protection

Privacy Problems

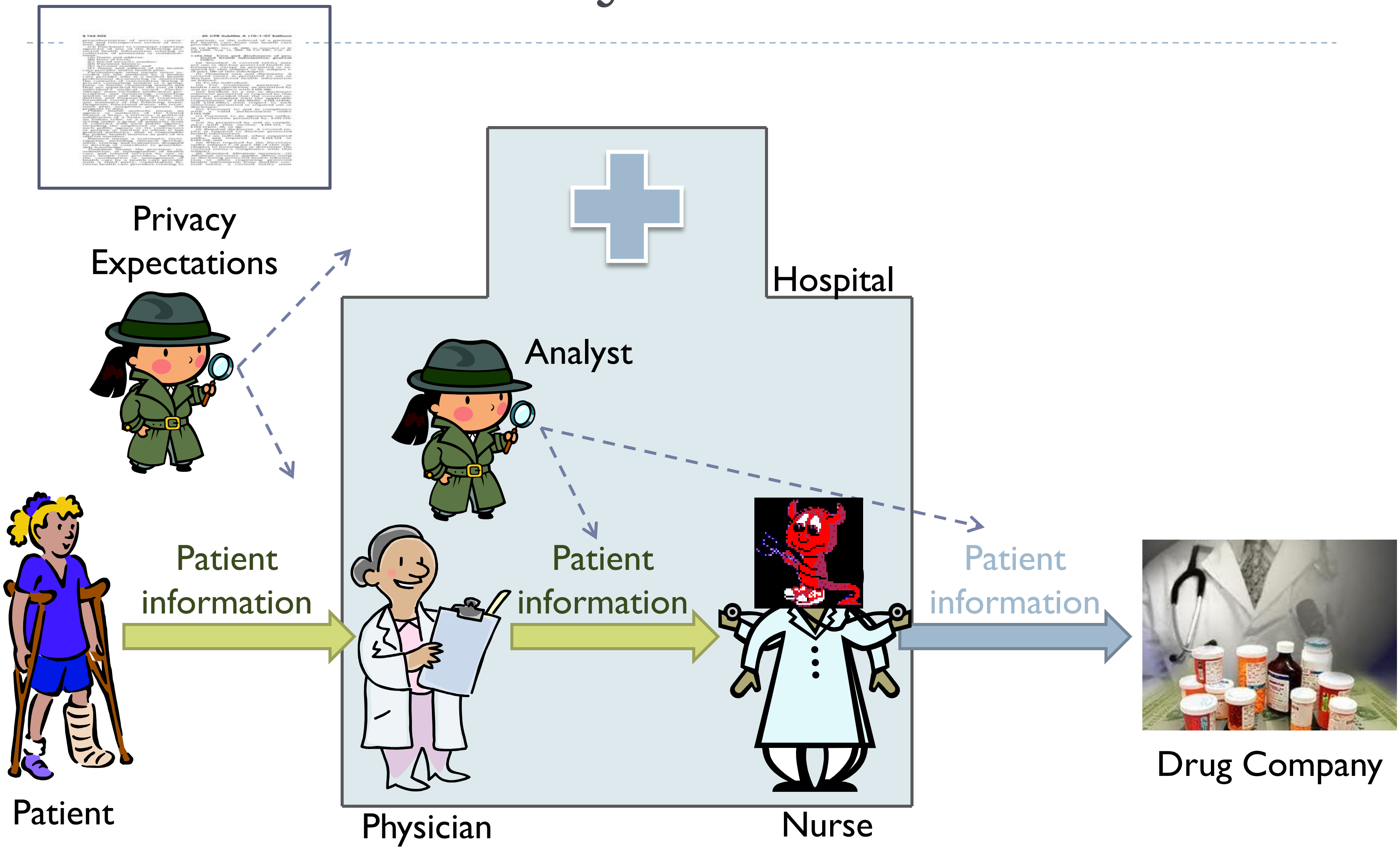
Module I: Privacy through Accountability

Research Challenge

Programs and People

Ensure organizations respect privacy expectations in the collection, use, and disclosure of personal information

Healthcare Privacy



Privacy Expectations

Hospital

Analyst

Patient information

Patient information

Patient information

Patient

Physician

Nurse

Drug Company

Example from HIPAA Privacy Rule

A covered entity may disclose an individual's protected health information (phi) to law-enforcement officials for the purpose of identifying an individual if the individual made a statement admitting participating in a violent crime that the covered entity believes may have caused serious physical harm to the victim

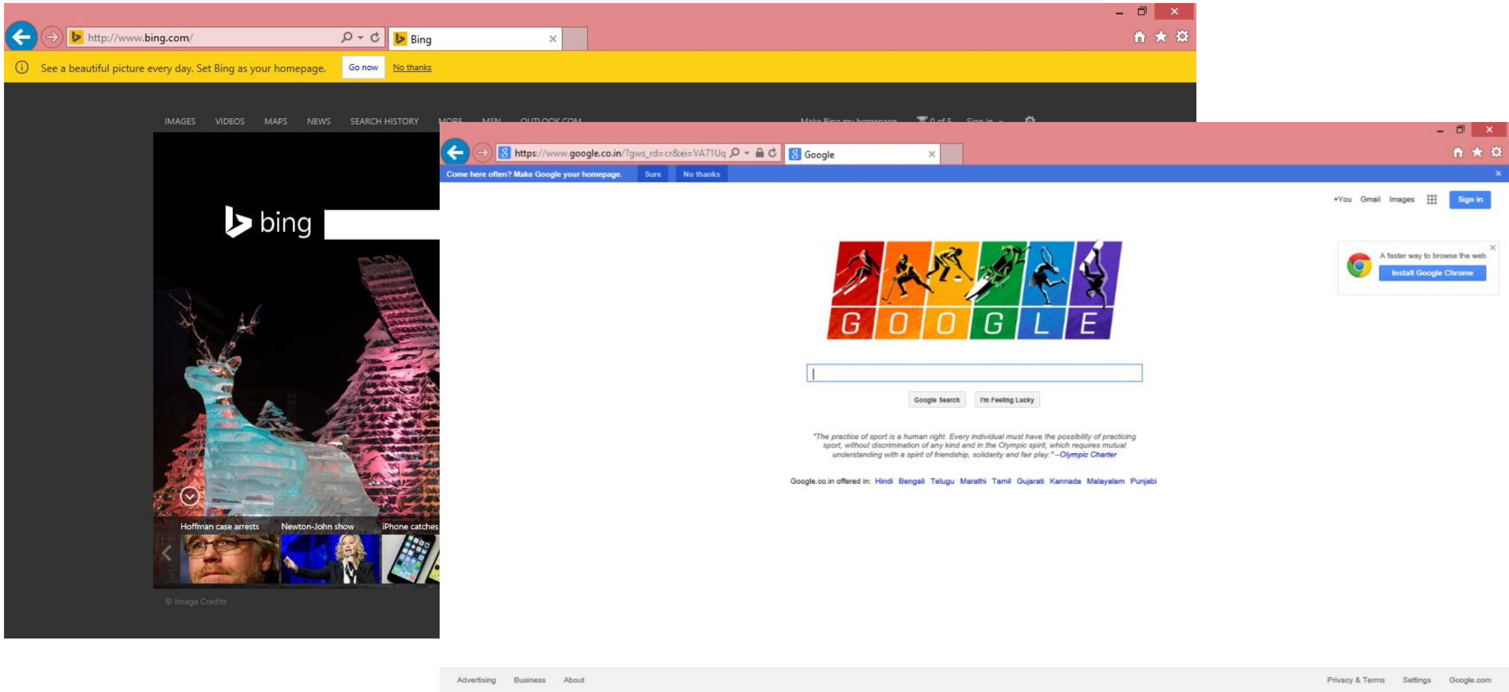
- Concepts in privacy policies
  - **Actions:** send(p1, p2, m)
  - **Roles:** inrole(p2, law-enforcement)
  - **Data attributes:** attr_in(prescription, phi)
  - **Temporal constraints:** in-the-past(state(q, m))

  - **Purposes:** purp_in(u, id-criminal))
  - **Beliefs:** believes-crime-caused-serious-harm(p, q, m)

Black-and-white concepts

Grey concepts

Web Advertising



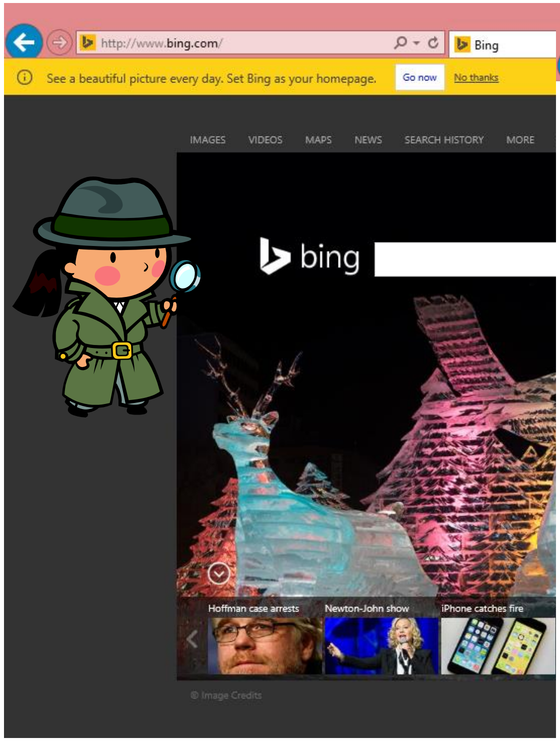
"The practice of sport is a human right. Every individual must have the possibility of practicing sport, without discrimination of any kind and in the Olympic spirit, which requires mutual understanding with a spirit of friendship, solidarity and fair play." –Olympic Charter

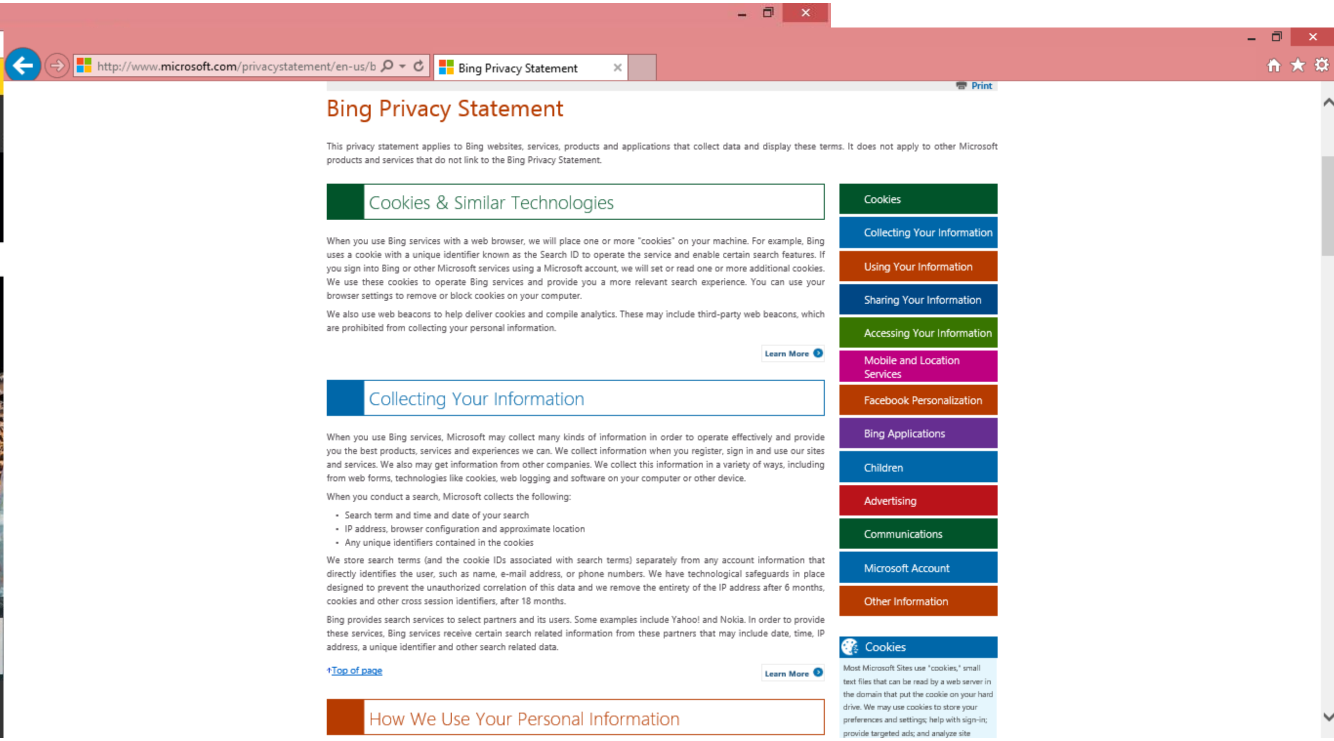
Google.co.in offered in: Hindi Bengali Telugu Marathi Tamil Gujarati Kannada Malayalam Punjabi

Example privacy policies:

- Not use detailed location (full IP address) for advertising
- Not use health information for advertising

Privacy Compliance for Bing





Bing Privacy Statement

This privacy statement applies to Bing websites, services, products and applications that collect data and display these terms. It does not apply to other Microsoft products and services that do not link to the Bing Privacy Statement.

Cookies & Similar Technologies

When you use Bing services with a web browser, we will place one or more "cookies" on your machine. For example, Bing uses a cookie with a unique identifier known as the Search ID to operate the service and enable certain search features. If you sign into Bing or other Microsoft services using a Microsoft account, we will set or read one or more additional cookies. We use these cookies to operate Bing services and provide you a more relevant search experience. You can use your browser settings to remove or block cookies on your computer.

We also use web beacons to help deliver cookies and compile analytics. These may include third-party web beacons, which are prohibited from collecting your personal information.

Learn More

Collecting Your Information

When you use Bing services, Microsoft may collect many kinds of information in order to operate effectively and provide you the best products, services and experiences we can. We collect information when you register, sign in and use our sites and services. We also may get information from other companies. We collect this information in a variety of ways, including from web forms, technologies like cookies, web logging and software on your computer or other device.

When you conduct a search, Microsoft collects the following:

- Search term and time and date of your search
- IP address, browser configuration and approximate location
- Any unique identifiers contained in the cookies

We store search terms (and the cookie IDs associated with search terms) separately from any account information that directly identifies the user, such as name, e-mail address, or phone numbers. We have technological safeguards in place designed to prevent the unauthorized correlation of this data and we remove the entirety of the IP address after 6 months, cookies and other cross session identifiers, after 18 months.

Bing provides search services to select partners and its users. Some examples include Yahoo! and Nokia. In order to provide these services, Bing services receive certain search related information from these partners that may include date, time, IP address, a unique identifier and other search related data.

↑Top of page

Learn More

How We Use Your Personal Information

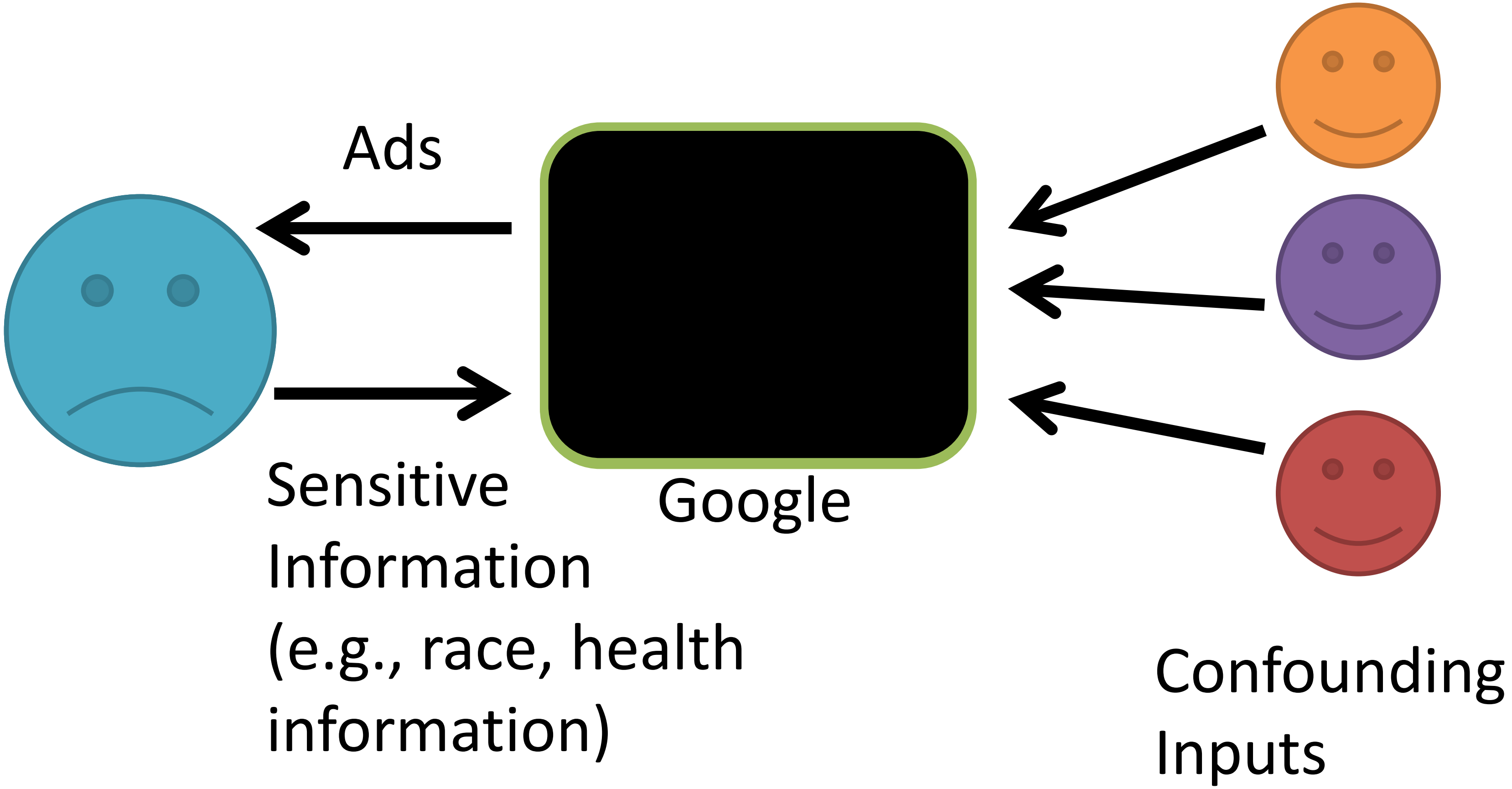
Cookies

Most Microsoft Sites use "cookies," small text files that can be read by a web server in the domain that put the cookie on your hard drive. We may use cookies to store your preferences and settings; help with sign-in; provide targeted ads; and analyze site

Setting:

- Auditor has access to source code

Web Privacy: Advertising



Ads

Sensitive Information (e.g., race, health information)

Google

Confounding Inputs

Web Privacy: Online Tracking

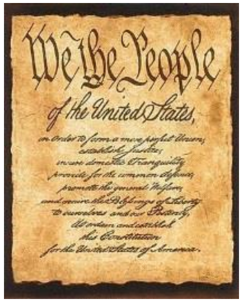
64

Independent tracking mechanisms on average on top-50 sites

Module I: Privacy through Accountability

- Formalize Privacy Policies
  - Precise semantics of privacy concepts

(restrictions on personal information flow)



- Enforce Privacy Policies
  - Accountability
    - Detect
    - Explain
    - Correct

http://www.andrew.cmu.edu/user/danupam/privacy.html

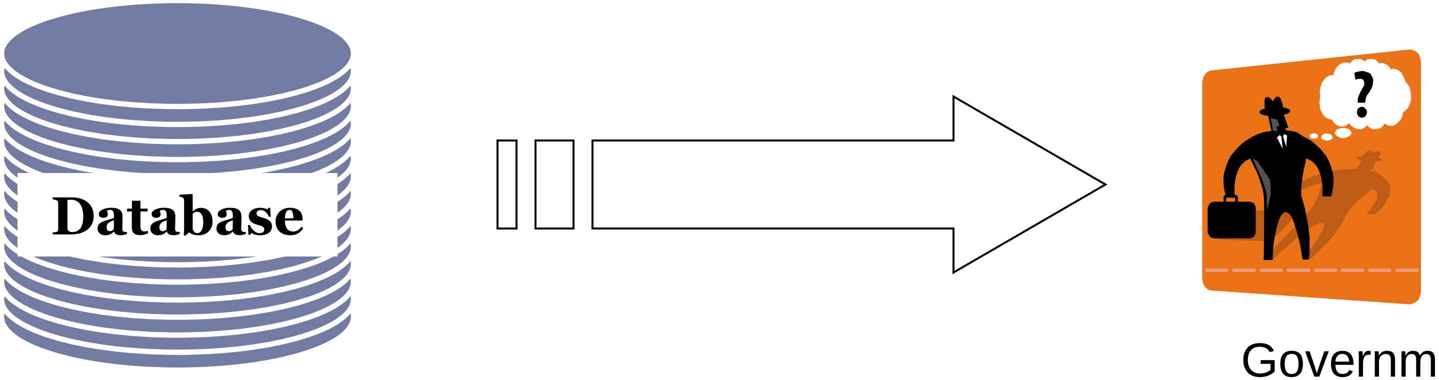
Module I: Learning Outcomes

- Understanding of real-world privacy policies and laws
- Methods for detecting privacy violations

- Experience with audit tools for healthcare privacy
- Experience with web tracking investigation tool

Module II: Protecting Privacy and Fairness in Big Data Analytics

Database Privacy Goals

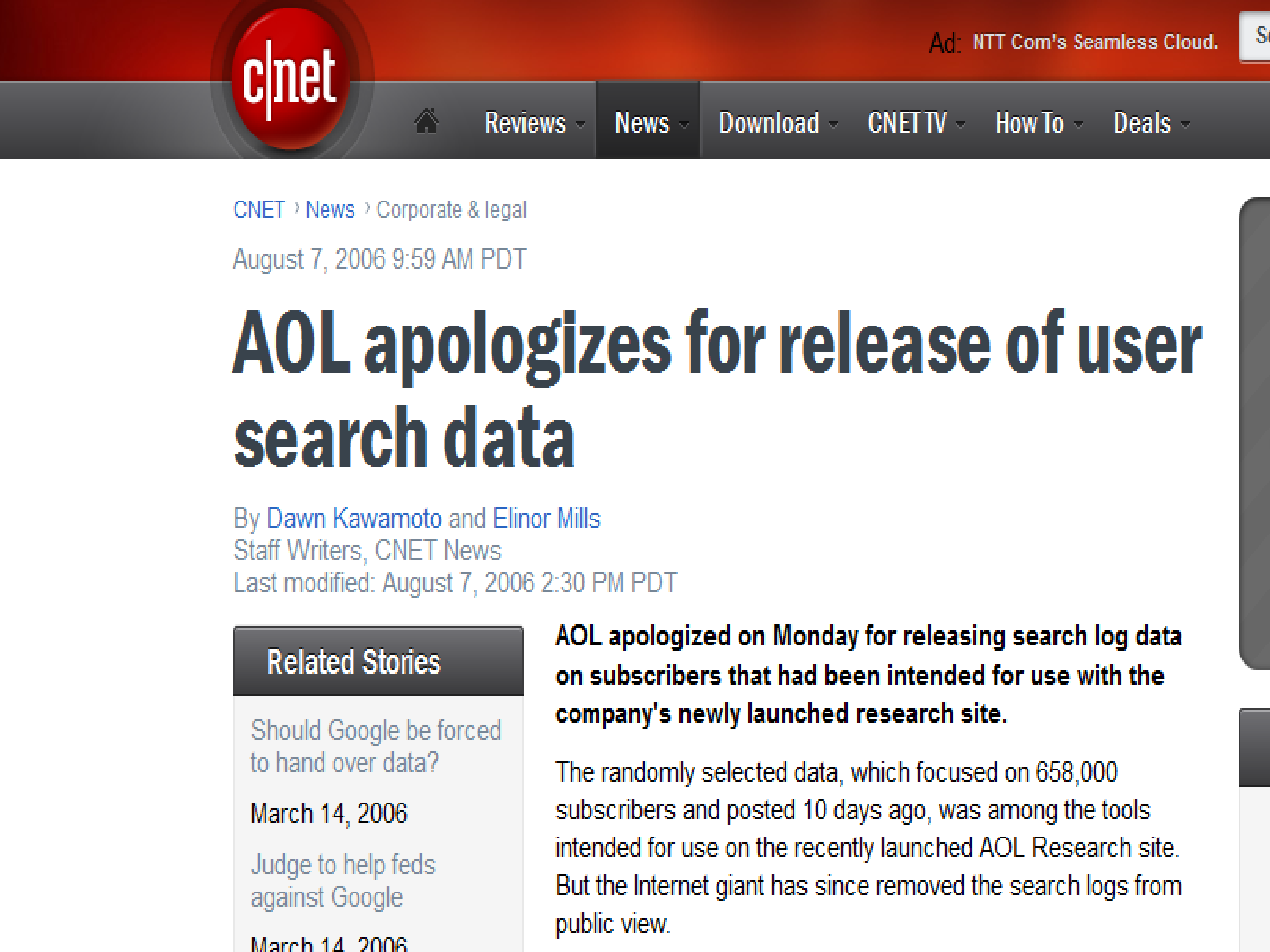


Government, marketers, researchers, …

- Health records
- Census data
- Web search records

Conflicting goals:

- Provide useful information
- Protect individual privacy



CNET › News › Corporate & legal

August 7, 2006 9:59 AM PDT

AOL apologizes for release of user search data

By Dawn Kawamoto and Elinor Mills
Staff Writers, CNET News
Last modified: August 7, 2006 2:30 PM PDT

AOL apologized on Monday for releasing search log data on subscribers that had been intended for use with the company's newly launched research site.

The randomly selected data, which focused on 658,000 subscribers and posted 10 days ago, was among the tools intended for use on the recently launched AOL Research site. But the Internet giant has since removed the search logs from public view.

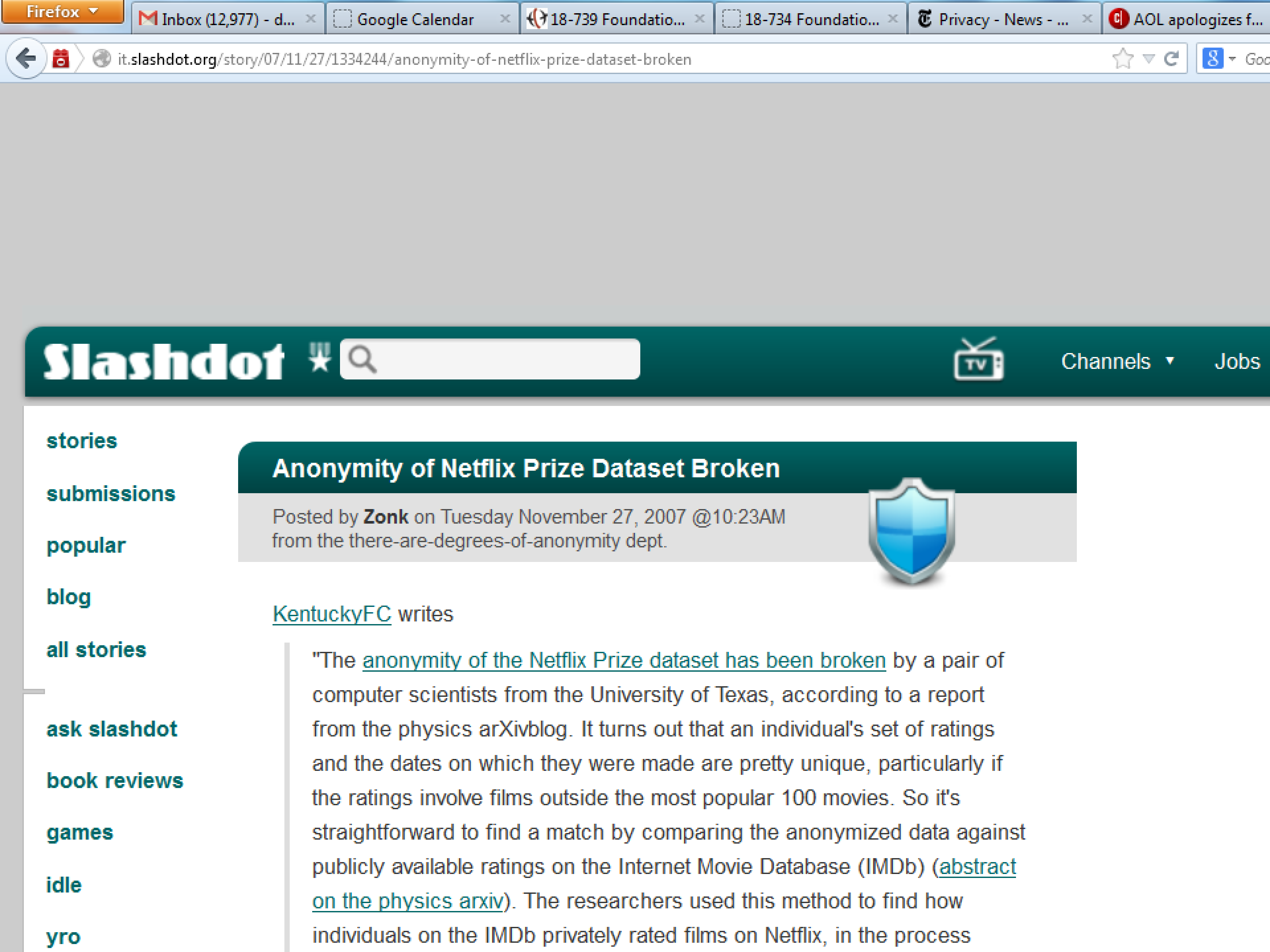
Related Stories

Should Google be forced to hand over data?

March 14, 2006

Judge to help feds against Google

March 14, 2006



Anonymity of Netflix Prize Dataset Broken

Posted by **Zonk** on Tuesday November 27, 2007 @10:23AM
from the there-are-degrees-of-anonymity dept.

KentuckyFC writes

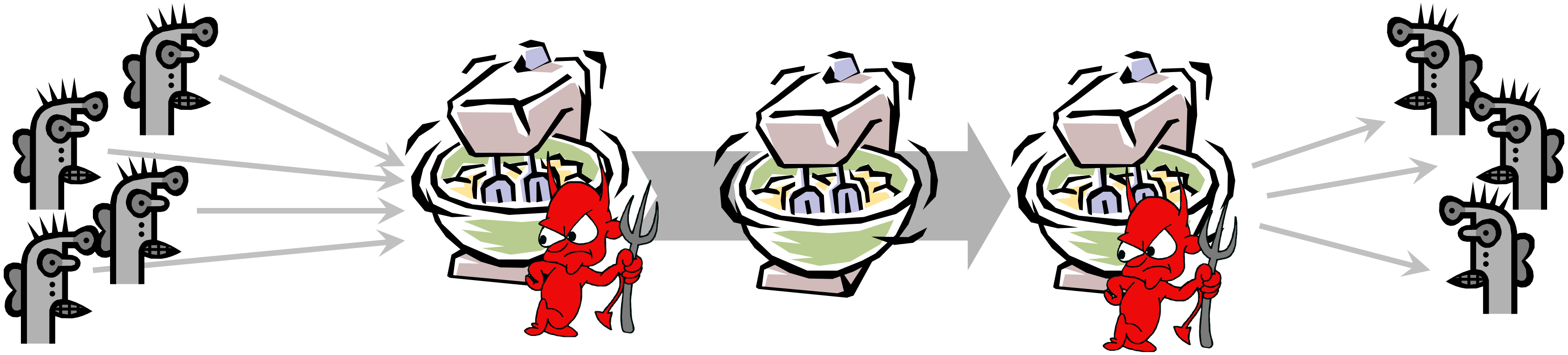
> "The anonymity of the Netflix Prize dataset has been broken by a pair of computer scientists from the University of Texas, according to a report from the physics arXivblog. It turns out that an individual's set of ratings and the dates on which they were made are pretty unique, particularly if the ratings involve films outside the most popular 100 movies. So it's straightforward to find a match by comparing the anonymized data against publicly available ratings on the Internet Movie Database (IMDb) (abstract on the physics arxiv). The researchers used this method to find how individuals on the IMDb privately rated films on Netflix, in the process

Module II: Learning Outcomes

- Understanding of pitfalls in anonymizing databases
- Understanding of methods for releasing privacy-preserving statistics and their limitations
- Understanding bias in machine learning and corrective measures
- Understanding transparency (explanations) for decisions of machine learning systems

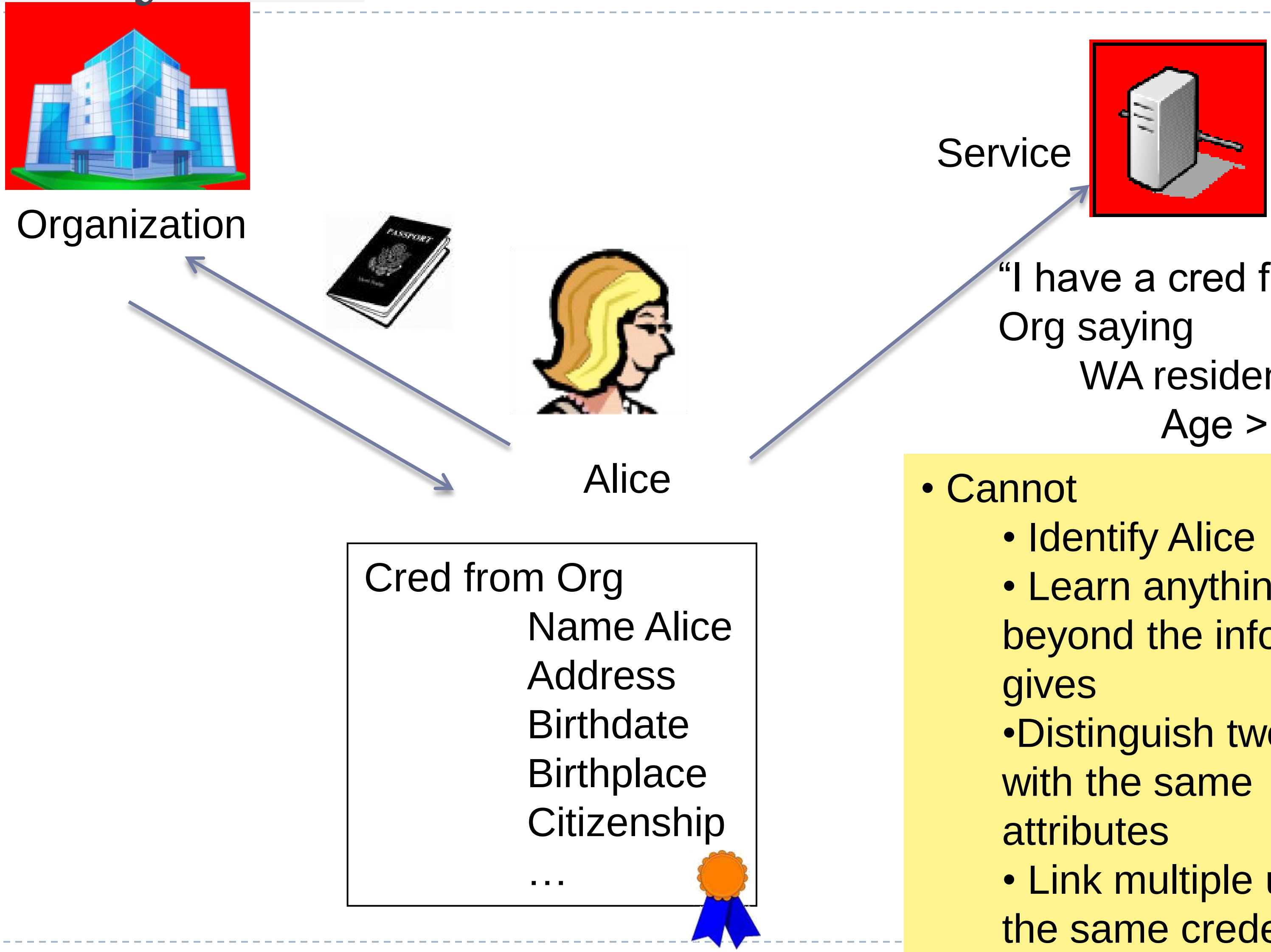
Module III: Cryptographic Mechanisms for Privacy Protection

Anonymous Communication



Slide: Melissa Chase

Anonymous Credentials



Organization

Service

Alice

“I have a cred from Org saying
WA resident
Age >18”

Cred from Org
Name Alice
Address
Birthdate
Birthplace
Citizenship
…

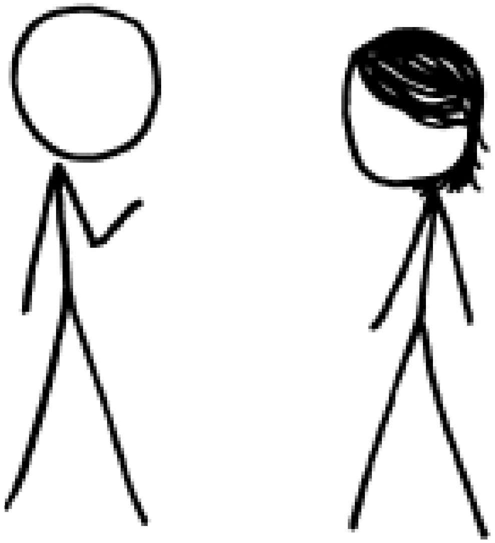
- Cannot
  - Identify Alice
  - Learn anything beyond the info she gives
  - Distinguish two users with the same attributes
  - Link multiple uses of the same credentials

Slide: David Evans et al.

Secure Two-Party Computation

Bob’s Genome: ACTG…
Markers (~1000): [0,1, …, 0]

Bob



Alice’s Genome: ACTG…
Markers (~1000): [0, 0, …, 1]

Alice

$$x = f(g_A, g_B)$$

Can Alice and Bob compute a function of their private data, without exposing anything about their data besides the result?

Module III: Learning Outcomes

- Understanding of cryptography behind
  - Anonymous communication
  - Anonymous credentials (zero-knowledge)
  - Biometric identification (secure computation)

Fall 2014 Course Projects

- Studies of personal information usage by Web services
  - Study on Facebook ads
  - Price Discrimination
  - Recommendations for news articles
  - Effect of cookies on Google ads
- Analytics to discover information usage by Web services
  - Abstaining Machine Learning
  - Ensemble Machine Learning
- Privacy Protecting the New York Taxicab Dataset
- Defense against Canvas Fingerprinting on the Web
- Privacy and Security issues of Android ads
- ML (Lasso Regression) over Encrypted Big Data

Fall 2015 Course Projects

- Secure Modular Embedding: Comparing Signals without revealing them
- Robust Ad Collection
- Inversion Attack on Machine Learning Models
- Privacy in Election Campaigns
- Improving Usability of Private Browsing Mode
- Investigating gender discrimination in popular employment websites
- Comparing Privacy Tools
- Google Advertising Platform Case study
- The Unexpected Danger of Multiple Social Media Accounts: Instagram and Twitter Reveal More than You Think
- Effects of Browser-Type on Internet Results

An Organizing Viewpoint

Privacy as a right to *restrictions* on *personal information flow*

Student Introductions

- Who are you?
- Why are you here?

Homework for Next Class

- Read the Fair Information Practices Principles

http://www.oecd.org/internet/ieconomy/oecdguidelinesontheprotectionofprivacyandtransborderflowsofpersonaldata.htm

- Critically read the entire privacy policy of a Web services company of your choice
  - Examine pairs of services owned by the same company (e.g., Facebook-Whatsapp)

Homework Continued

Discussion questions:

- Try to find one example of a piece of the policy that maps to each principle.
- Can you find examples of principles that are not reflected in the policy?
- Can you find examples of policy clauses that reflect a principle that is not included in these principles?
- Are there policy clauses that could be more restrictive or less restrictive with respect to information use in order to better adhere to the principles?
- Are there parts of the policy that are too vague? If so, suggest alternatives.
- Are there conflicts in policies of service pairs owned by the same company?

Thanks! Questions?