

# Privacy and Composability (Part 1)

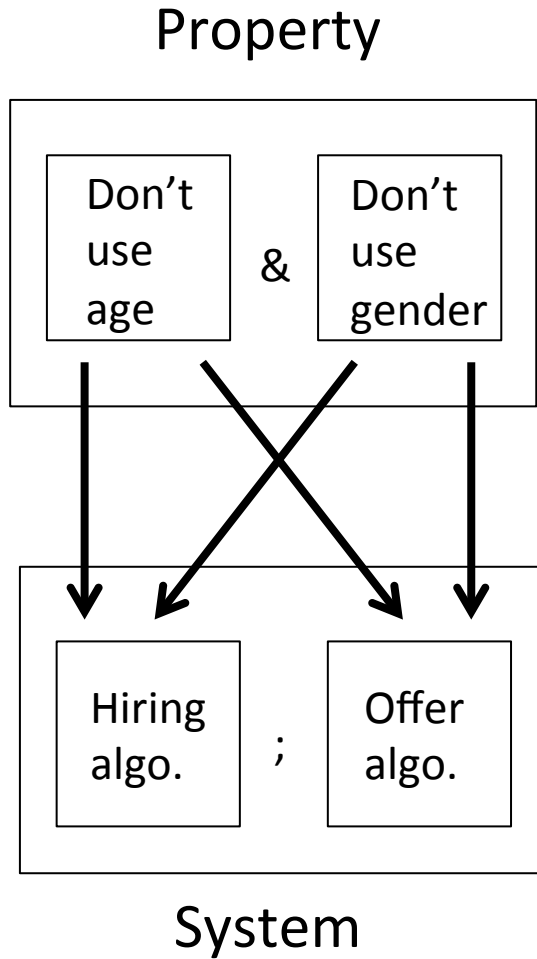
Anupam Datta

Associate Professor

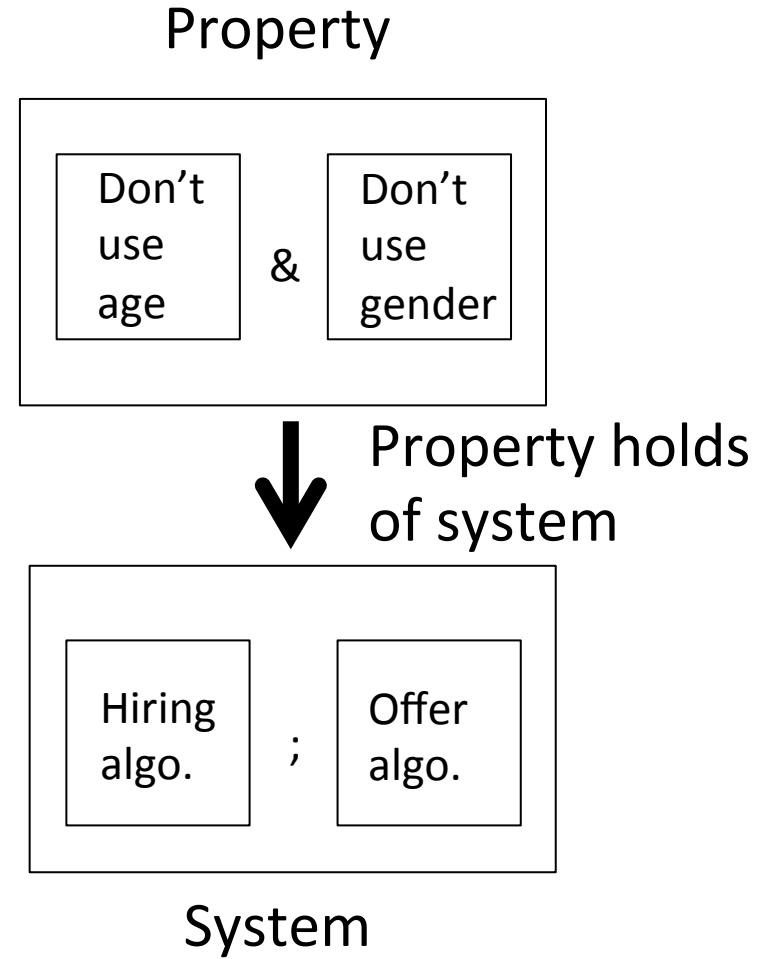
CSD, ECE, CyLab

Carnegie Mellon University

# Composition

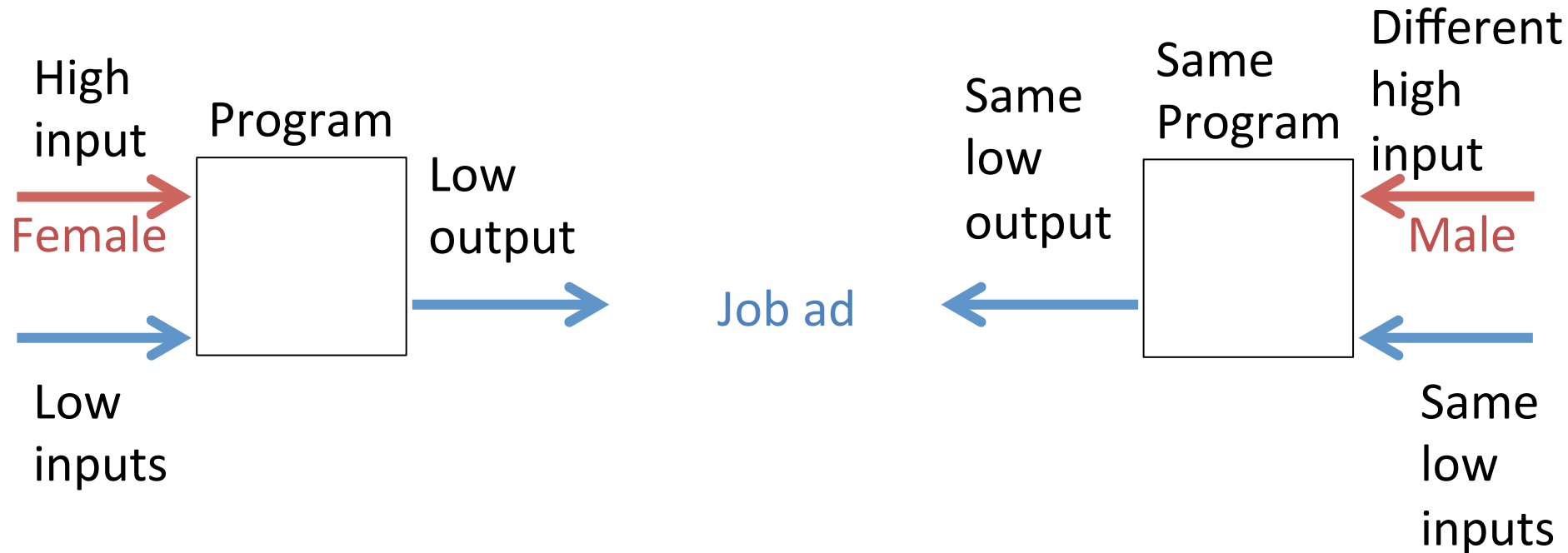


Implies  
that

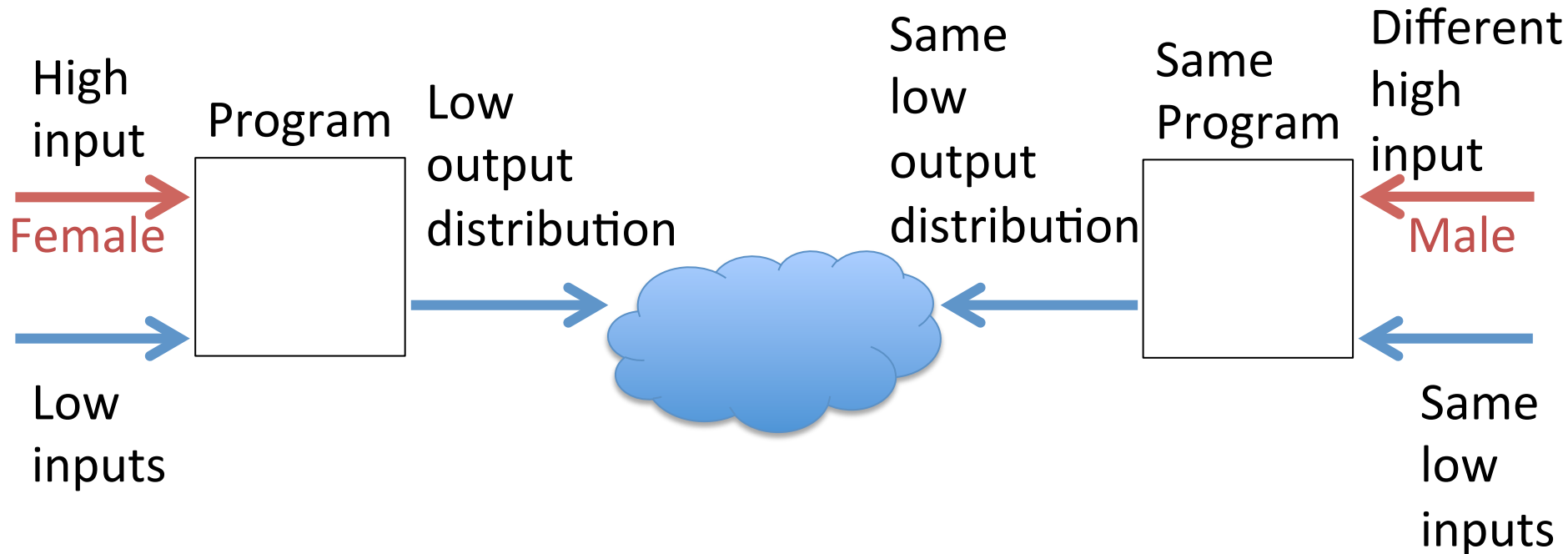


Privacy as a right to restrictions on  
personal information flow

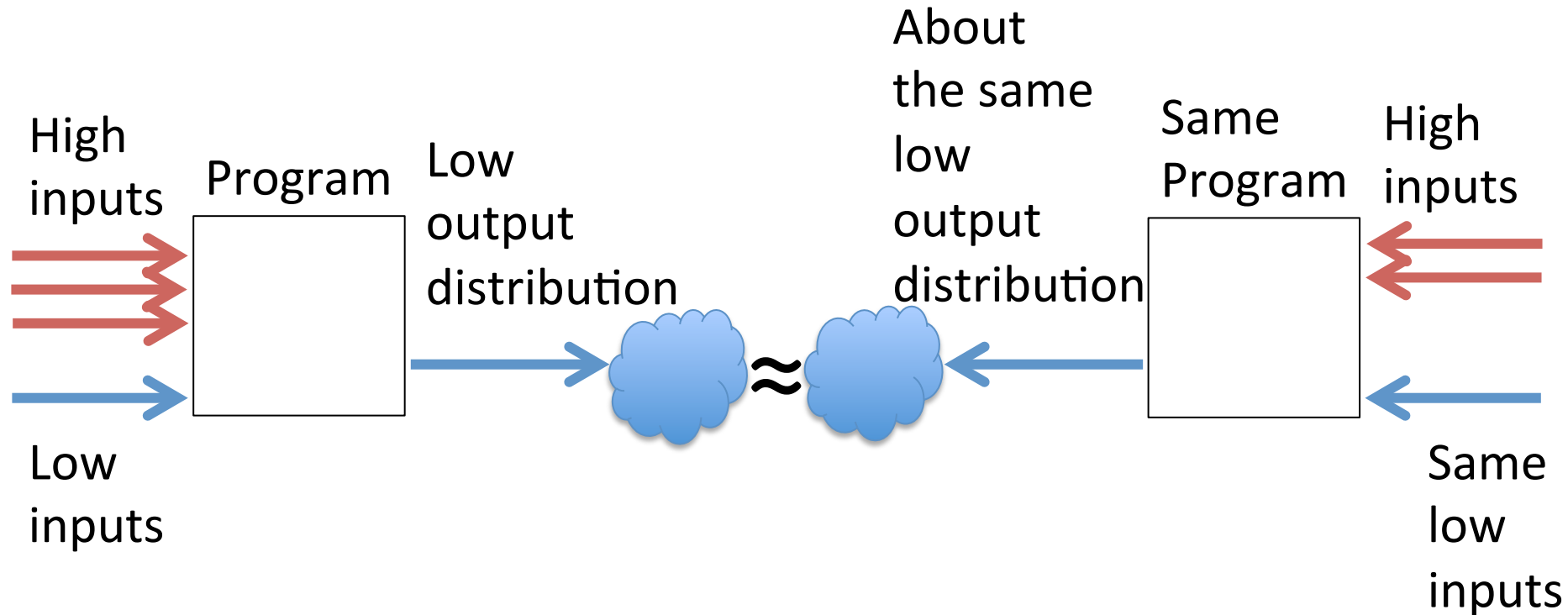
# Noninterference



# Probabilistic Noninterference



# Differential Privacy



# 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

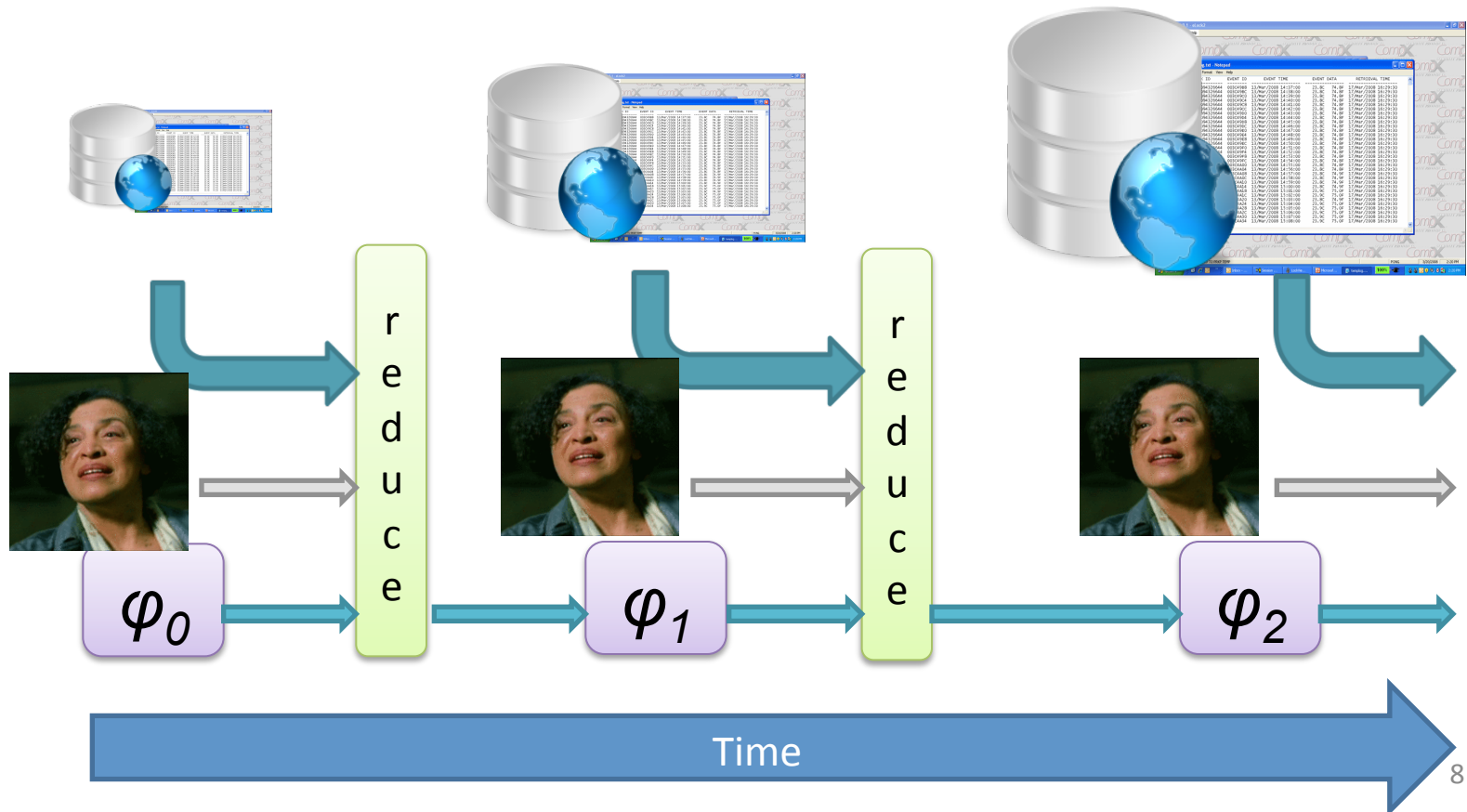
Grey concepts

# Reduce Algorithm

$$\text{reduce}(\mathcal{L}, \varphi) = \varphi'$$

Logs

Policy

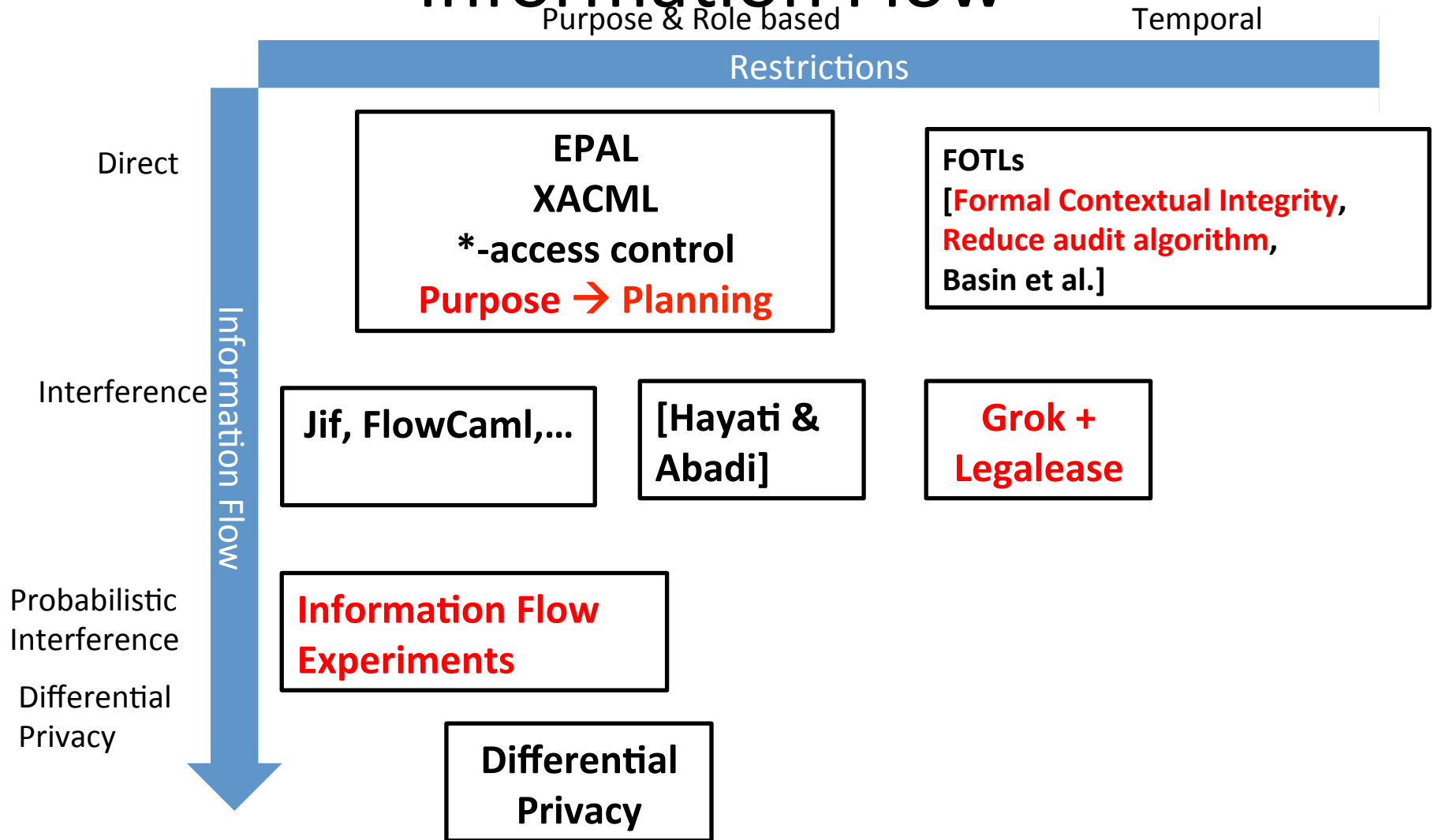




# Privacy as Restrictions on Personal Information Flow

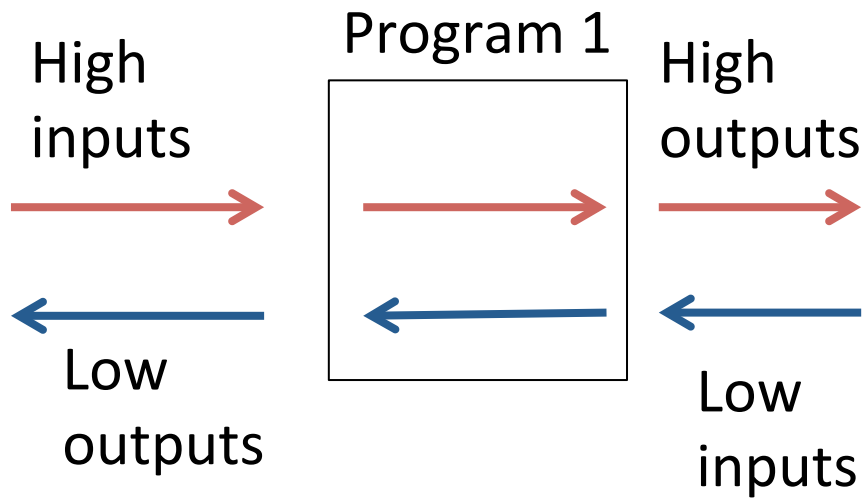
Purpose & Role based

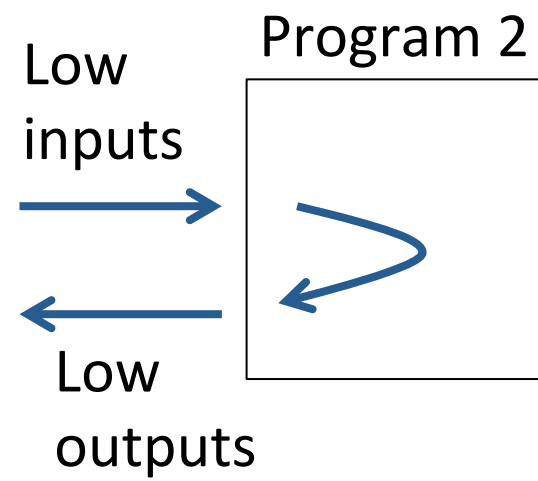
Temporal

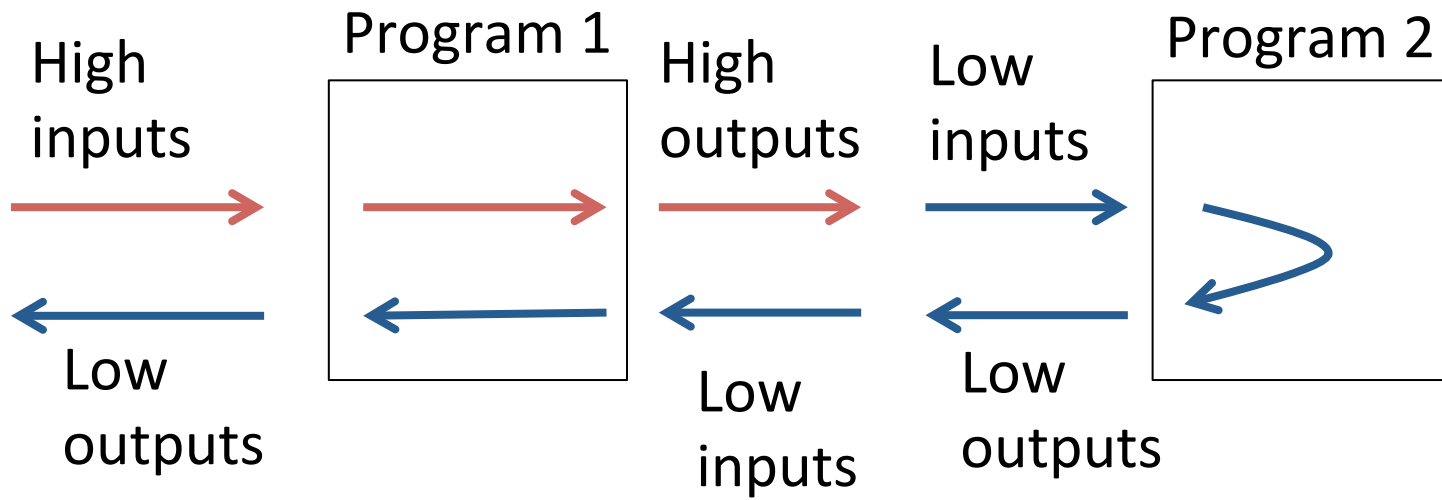


# Privacy and Composition (Part 2)

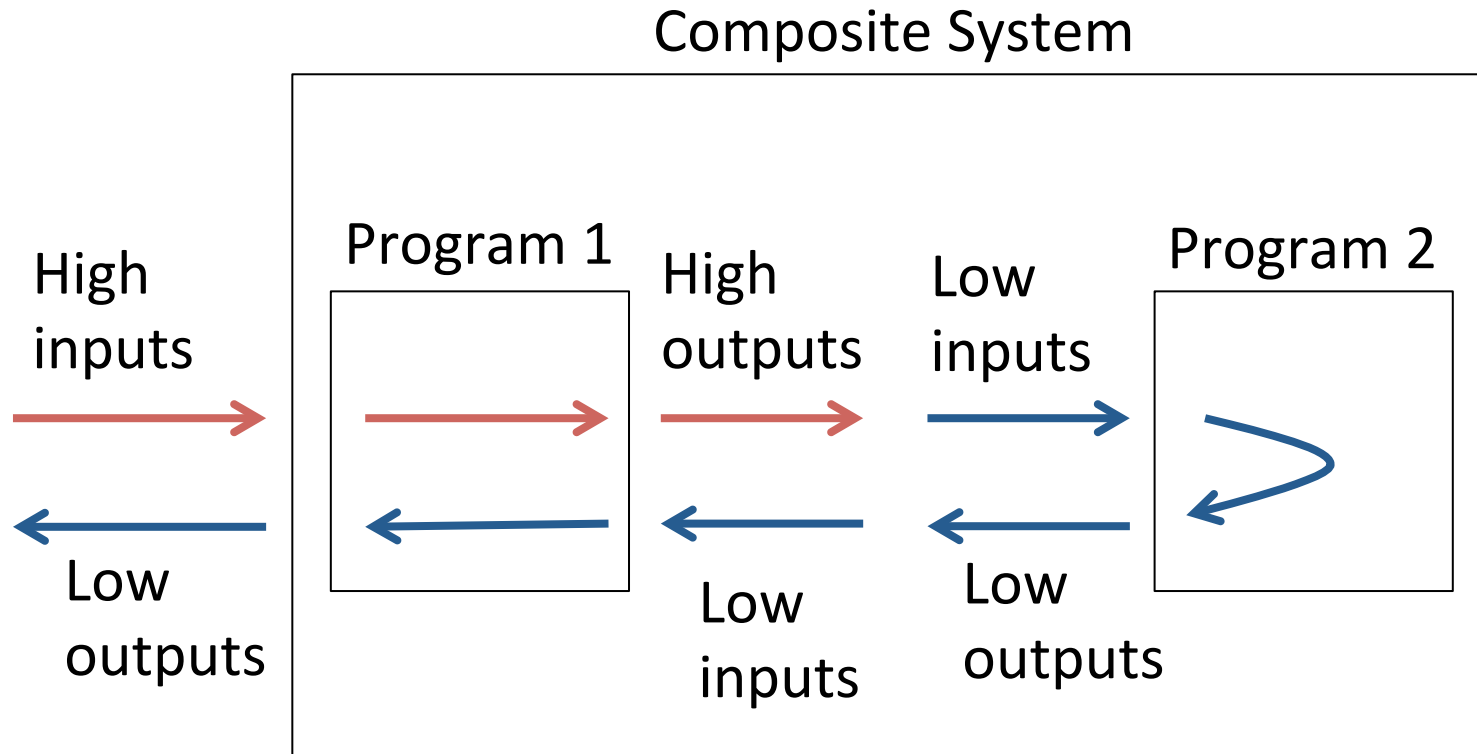
Michael Carl Tschantz  
International Computer Science Institute

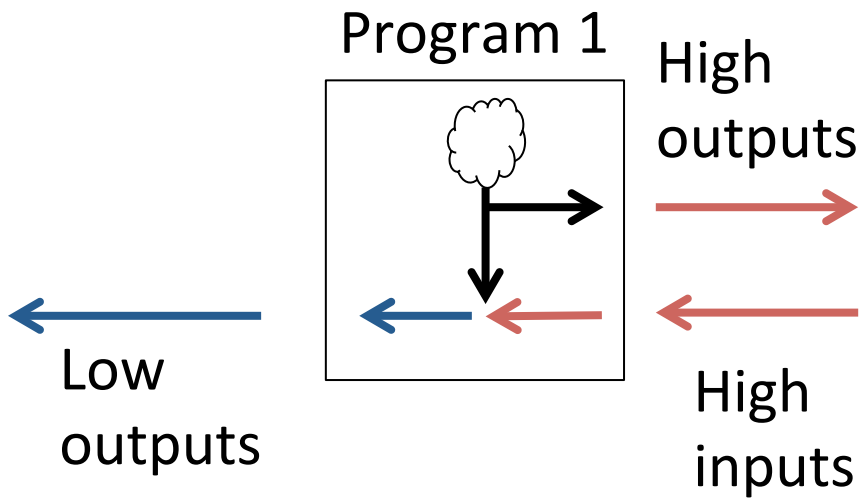


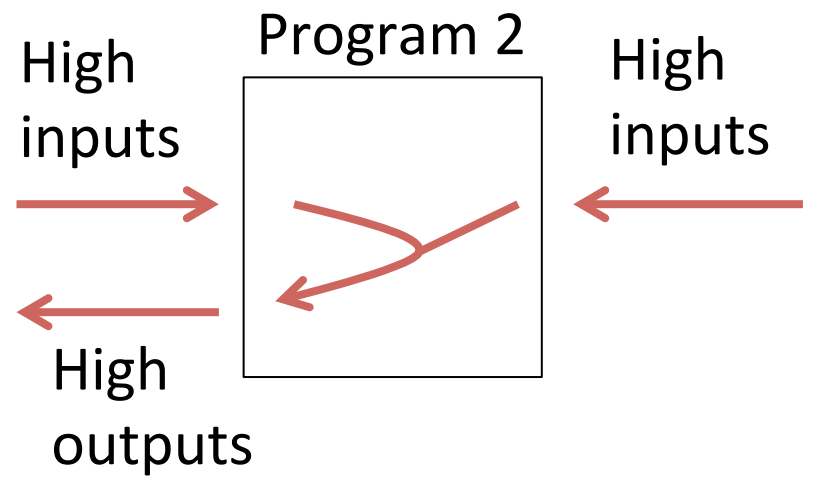




# Failure of Composition

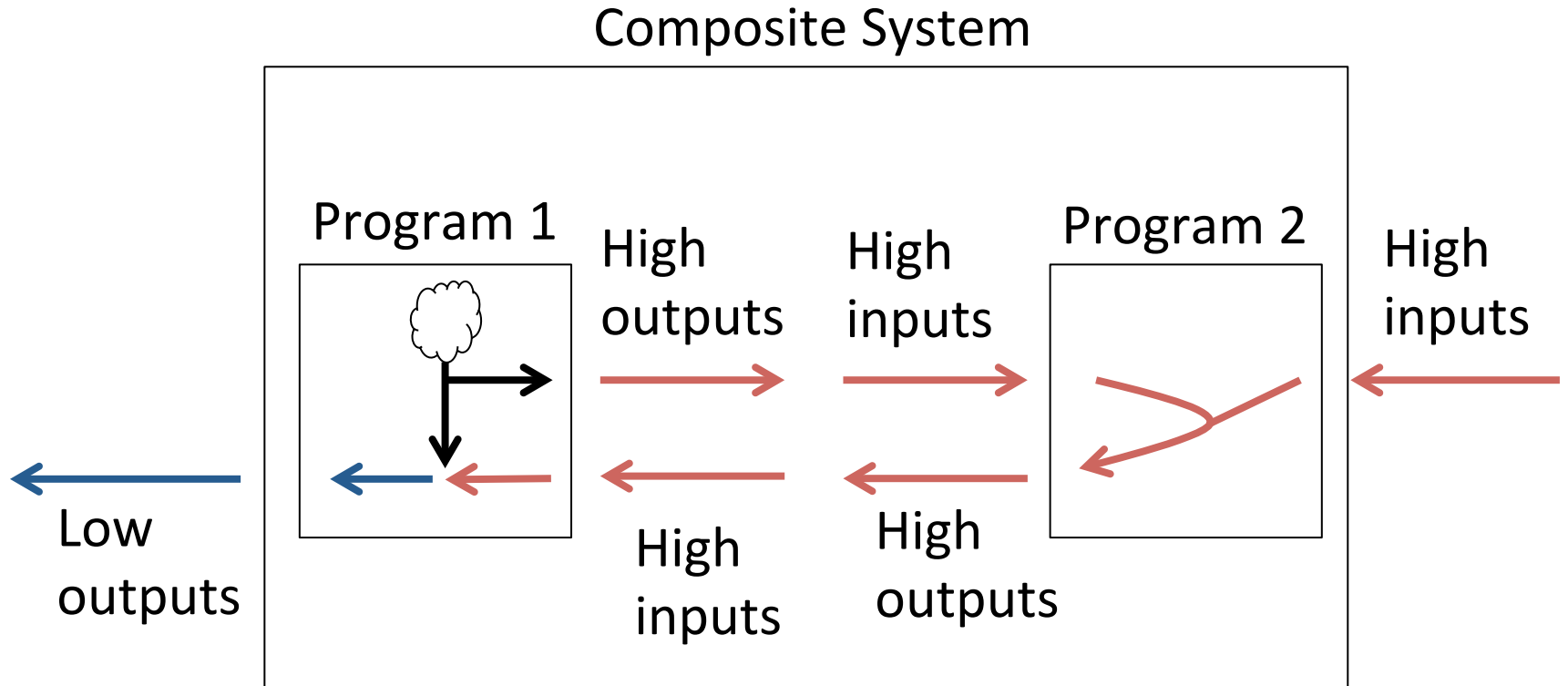








# Failure of Composition



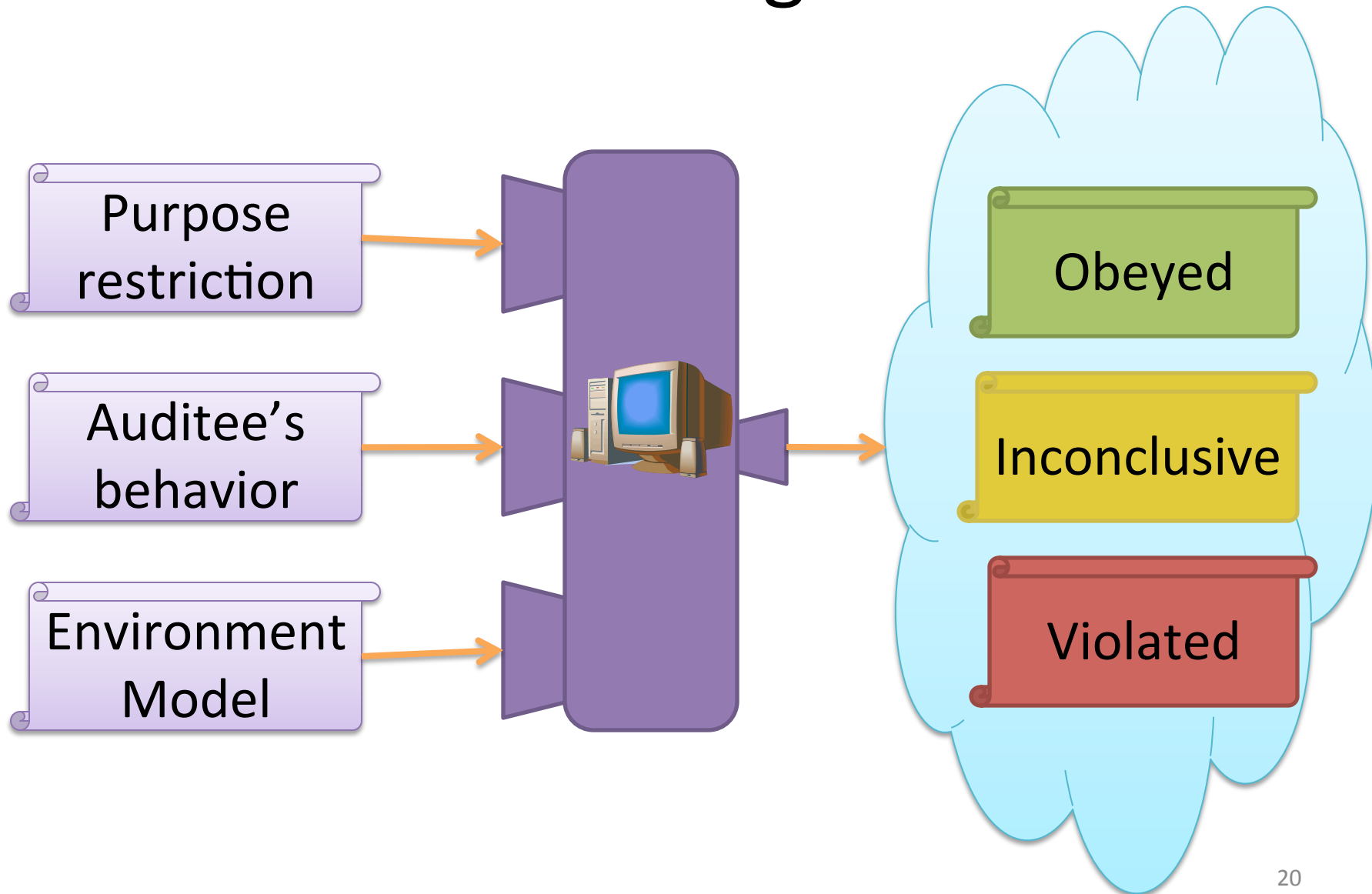
# Noninterference Compositional and Not

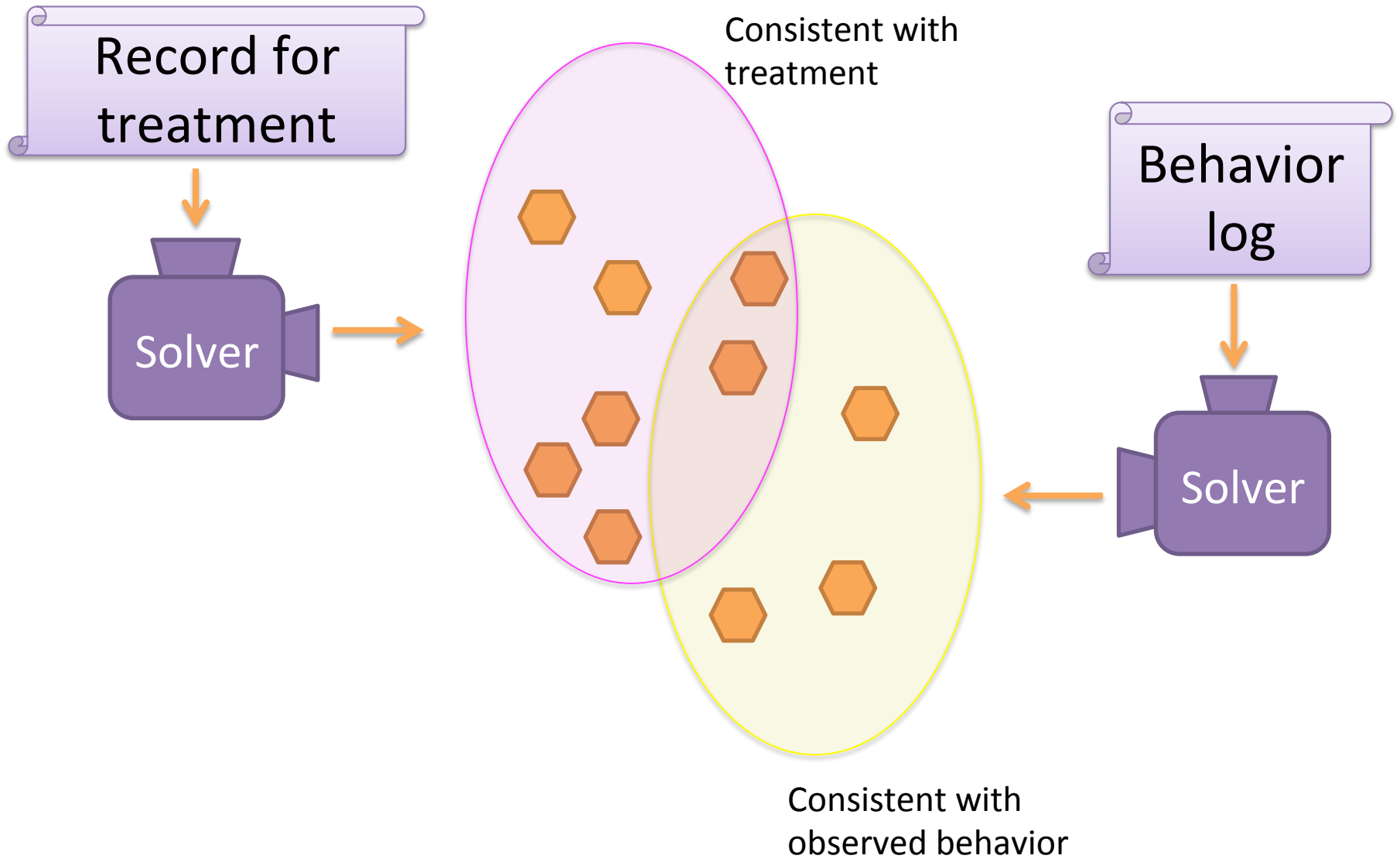
Feedback	Not in general
Cascade (sequential)	Yes
Product (parallel)	Yes

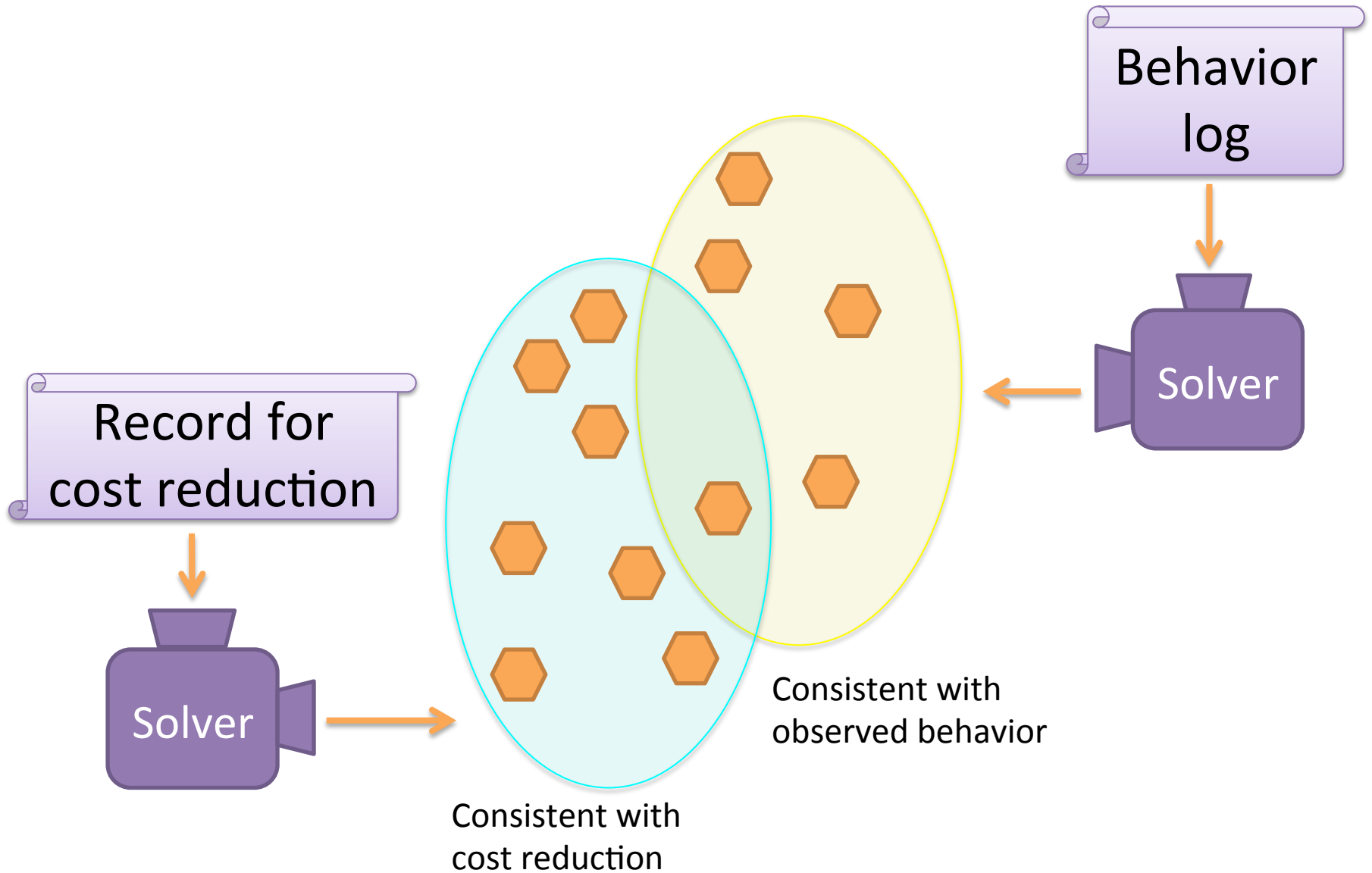
# Purpose Restrictions in Privacy Policies

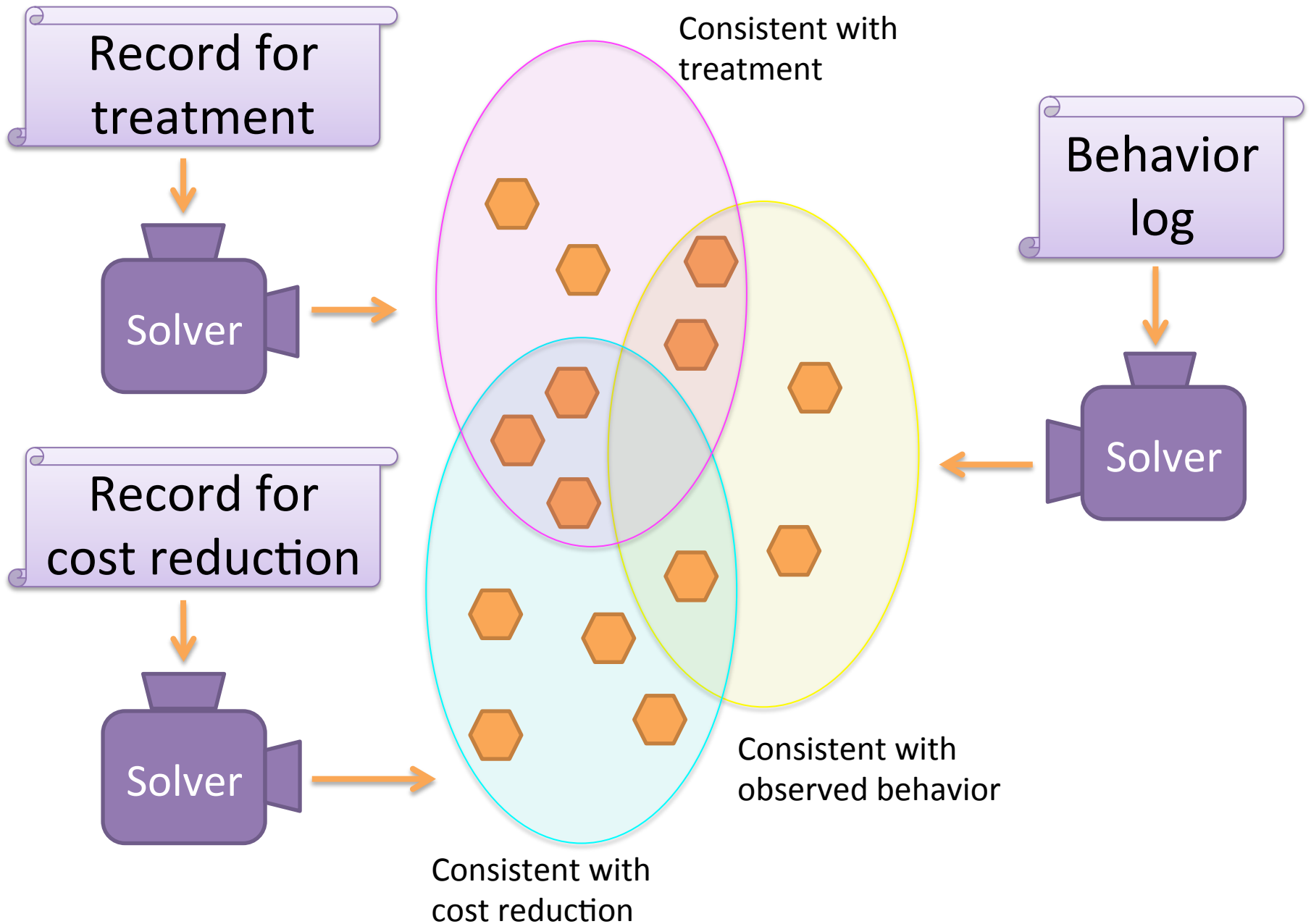
- Yahoo!'s practice is **not** to use the content of messages [...] **for** marketing **purposes**.
- By providing your personal information, you give [Social Security Administration] consent to use the information **only for** the **purpose** for which it was collected.

# Auditing









# Purpose Compositional and Not

Simultaneous

No

Parallel

Yes

Sequential

Yes



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# 'We'll be back': Hong Kong protesters chant as camp site dismantled

Reuters | Dec 12, 2014, 08:39 AM IST

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Police officers stand guard before they move on to remove protesters from a road written 'We Will Be Back' with tarps at an occupied area outside government headquarters in Hong Kong.

HONG KONG: Hong Kong police arrested pro-democracy activists and cleared most of the main protest site on Thursday, marking an end to more than two months of street demonstrations in the Chinese-controlled city, but many chanted: "We will be back".

Most activists chose to leave the Admiralty site, next to the Central business area, peacefully, despite their demands for a free vote not being met. But the overall mood remained defiant.

Hong Kong Federation of Students leader Alex Chow said: "You might have the clearance today but people will come back on to the streets

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Day 4: 3rd Session - Australia lead by 280 runs

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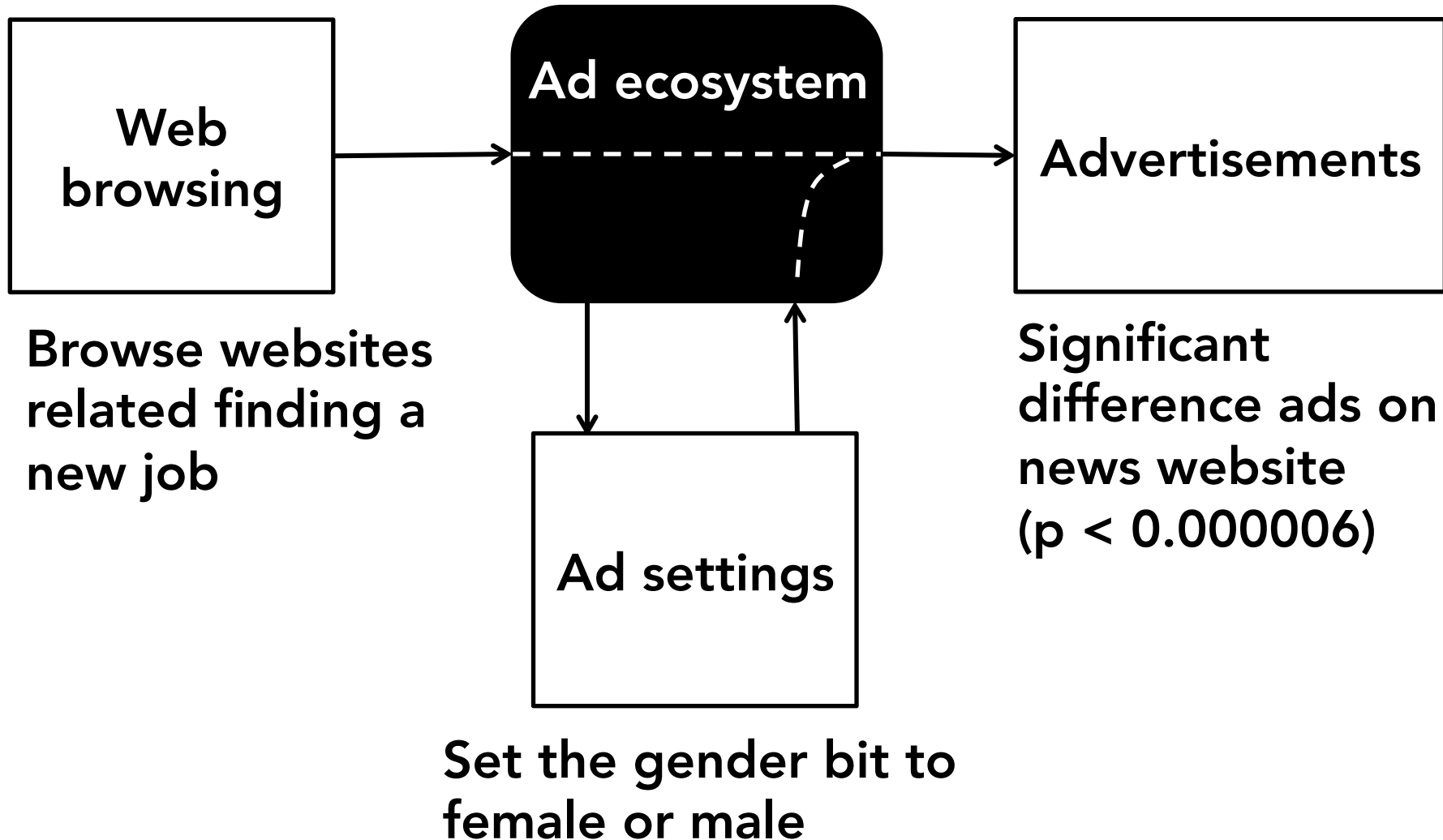
- ☐ Top News (Daily)
- ☐ Tech News (Daily)

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	<div> Search</div>	<div> Google ads across the web</div>	<div> YouTube</div>
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Age	N/A	<div><div>25-34</div><div>Edit</div></div> <div>Based on the websites you've visited</div>	
Languages	N/A	<div><div>English</div><div>Edit</div></div> <div>Based on the websites you've visited</div>	
Interests	N/A	<div><div>Air Travel, and 30 more</div><div>Edit</div></div> <div>Based on the websites you've visited</div>	
Opt-out settings	You've opted out of <i>interest-based</i> ads on Google. <a href="#">Opt in</a> to <i>interest-based</i> ads on Google		<div><div>Opt out</div> of <i>interest-based</i> Google ads across the web</div>

# Discrimination



# Discrimination Explanation

## Female Group

### Jobs (Hiring Now)

[www.jobsinyourarea.co](http://www.jobsinyourarea.co)

45 vs. 8

### 4Runner Parts Service

[www.westernpatoyotaservice.com](http://www.westernpatoyotaservice.com)

36 vs. 5

### Criminal Justice Program

[www3.mc3.edu/Criminal+Justice](http://www3.mc3.edu/Criminal+Justice)

29 vs. 1

## Male Group

### \$200k+ Jobs - Execs Only

[careerchange.com](http://careerchange.com)

311 vs. 1816

### Find Next \$200k+ Job

[careerchange.com](http://careerchange.com)

7 vs. 36

### Become a Youth Counselor

[www.youthcounseling.degreeleap.com](http://www.youthcounseling.degreeleap.com)

0 vs. 310

# Out Bided on Women but Not Men

## Bids for Females

\$7 Makeup

\$5 Dress

**\$4 Job**

\$2 Hair Salon

\$1 Car

## Bids for Males

**\$4 Job**

\$1 Car

# Who's to Blame?

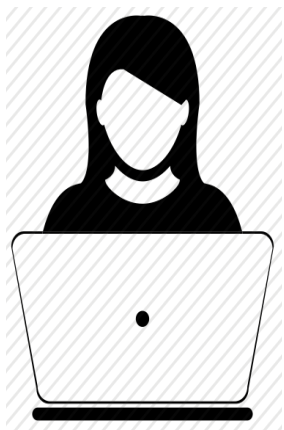
- Career coaching service: place same bids for females and males
- Other advertisers: place bids on females for products that cater only to women
- Google: show the highest bid

# Backup

# Correctness of Reduce

**Theorem 3.2** (Partial correctness of reduce). *If  $\text{reduce}(\mathcal{L}, \varphi) = \psi$  and  $\mathcal{L} \leq \mathcal{L}'$ , then (1)  $\mathcal{L}' \models \varphi$  iff  $\mathcal{L}' \models \psi$  and (2)  $\mathcal{L}' \models \overline{\varphi}$  iff  $\mathcal{L}' \models \overline{\psi}$ .*



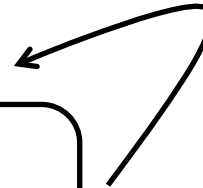


**Input** →  
← **Output**

**The Bartlett  
Group**

**Other  
advertisers**

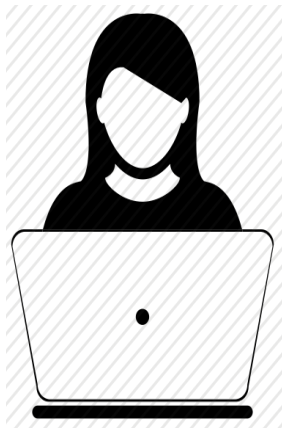
**Google**



**Websites**

**Male  
users**

**Female  
users**



Input →  
← Output

**The Bartlett  
Group**

↓  
**Show to males**

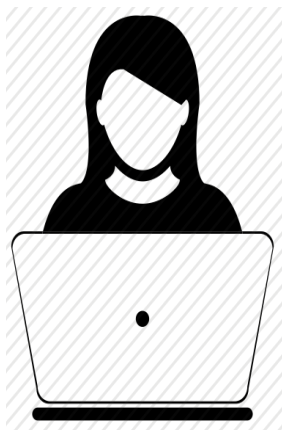
**Google**

**Other  
advertisers**

**Websites**

**Male  
users**

**Female  
users**



Input →  
← Output

**The Bartlett  
Group**

**Other  
advertisers**

↓ Show to both

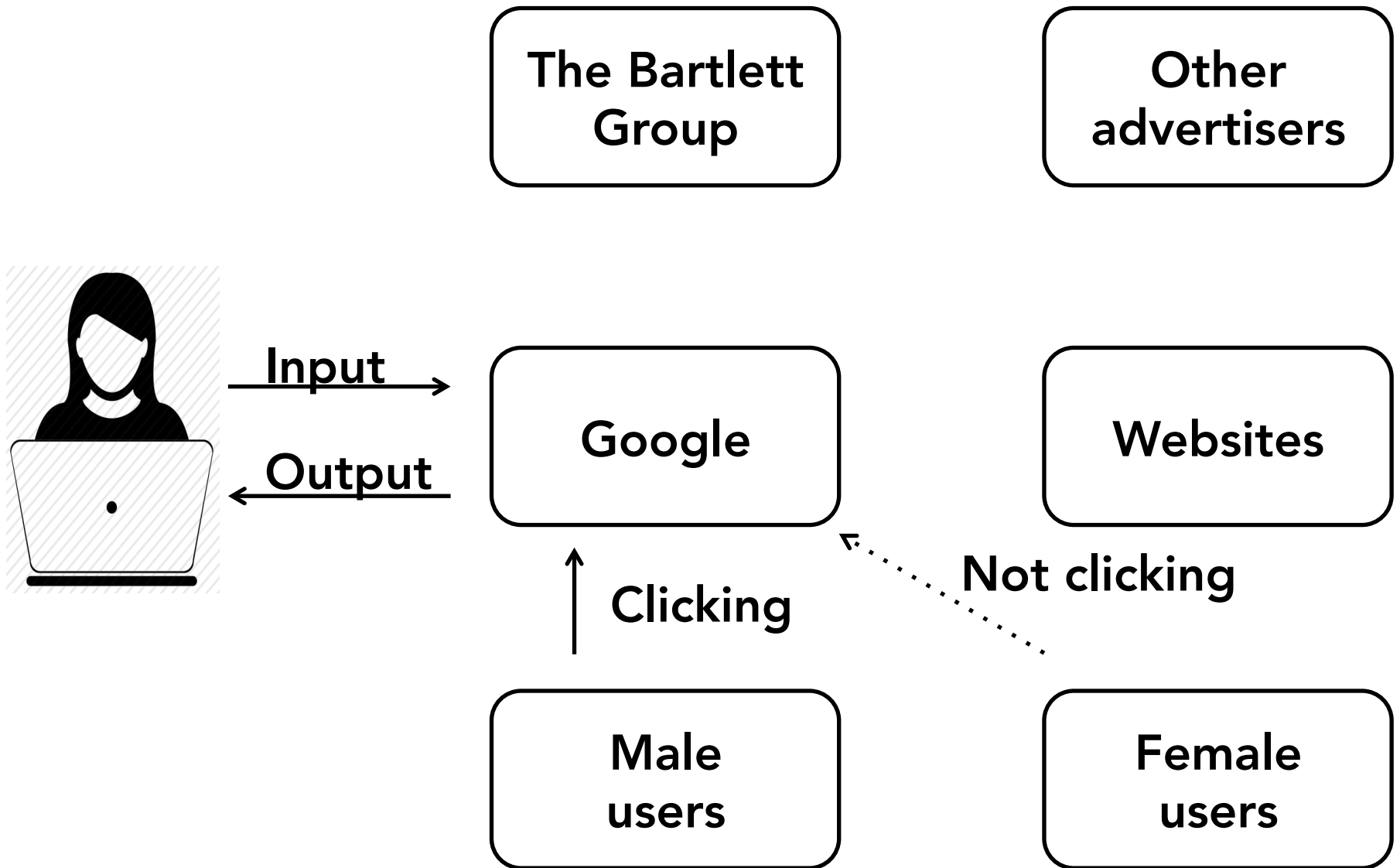
↙ Show to females

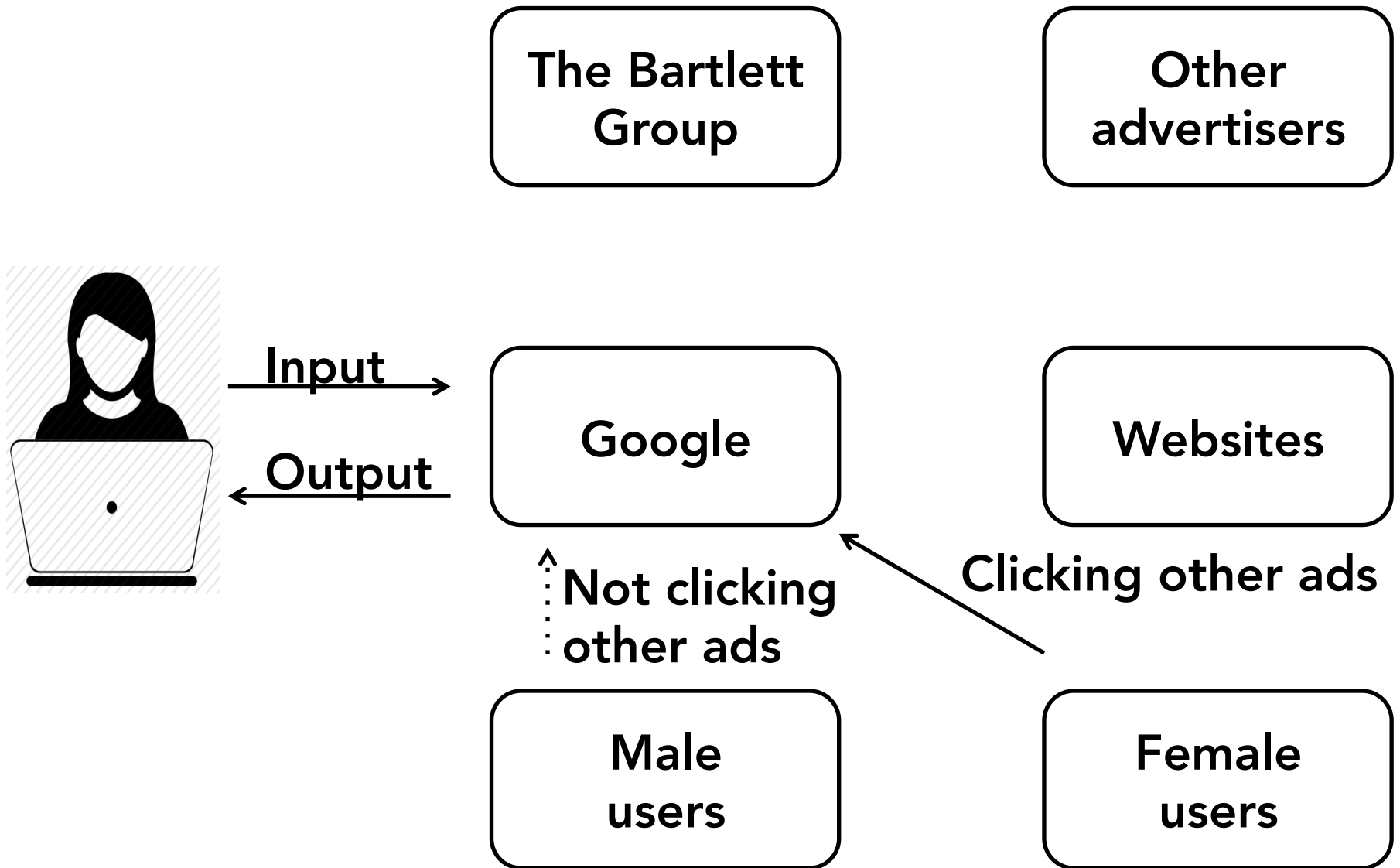
**Google**

**Websites**

**Male  
users**

**Female  
users**





# Possible Reasons

1. Google programmed the system to treat genders differently
2. Google's targeting algorithm found and responded to a difference in how males and females were clicking on ads
3. The advertiser targeted the ad differently across genders
4. The advertiser targeted a group correlated with gender
5. The advertiser was out bided on women
6. Some other reason we haven't thought of
7. Some combination of the above