Sessions

Slides by Andrew DeOrio

Agenda

- Sessions
- Cookies
- Third-party cookies
- Example from project 2

The web remembers you

- How does a shopping cart stay full?
- How do I log in?
- How does Google remember my past queries?

Sessions

- Goal: maintain state with stateless HTTP
- This is called a **session**

But HTTP is stateless!!!

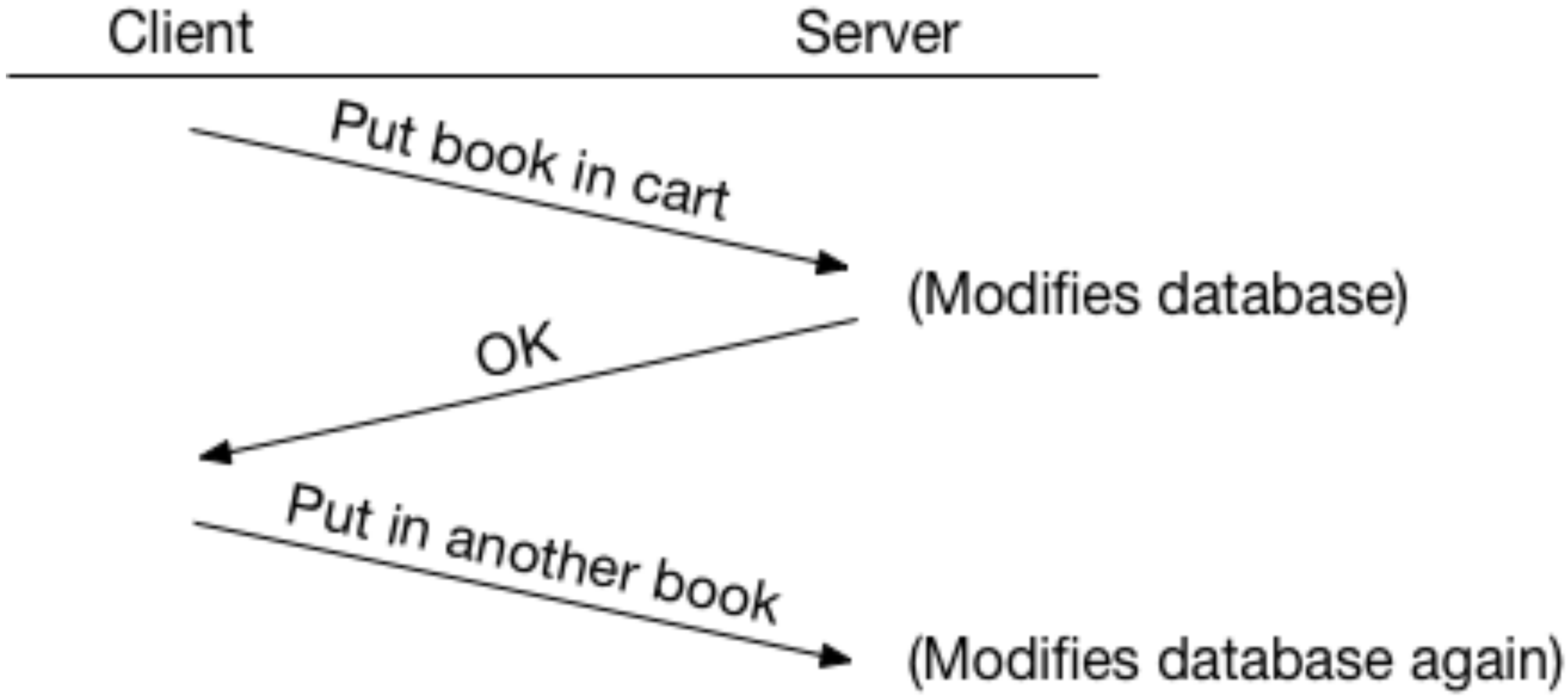
- Principle of the web is to build in layers, with each layer as simple as possible
- Could have built state *into* HTTP
  - State not always required
  - When state is needed, the reasons are various, and corresponding sizes vary
  - Supporting all this in HTTP would have made it bloated
- So instead, build state *on top of* HTTP

Sessions

- A session is a single "interaction" between the site and user
  - Precise definition depends on application

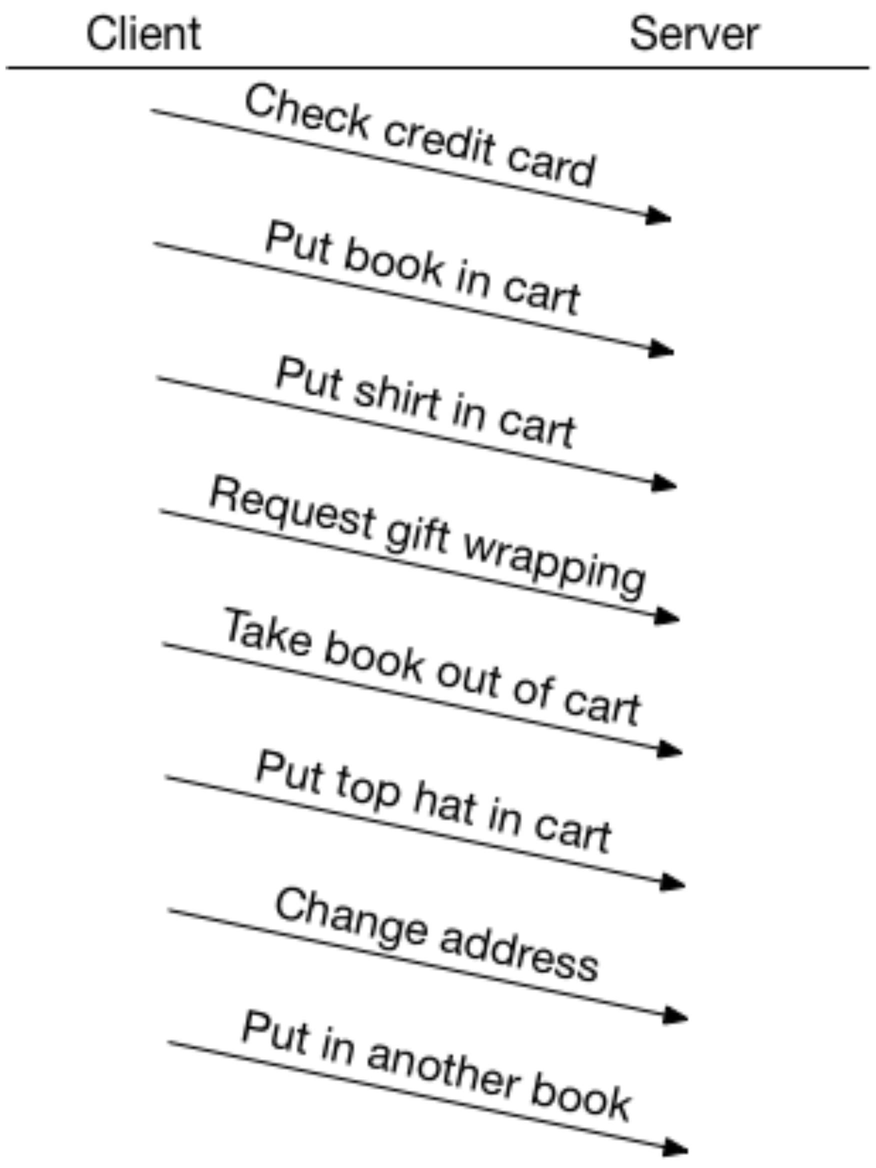
- Example: Facebook or Gmail login
- Example: Amazon cart
  - Even when you’re not logged in

Session perspectives - client



Session perspectives: server

- A server must track many sessions at once
- How can it tell the difference between clients?



Sessions and stateless HTTP

- HTTP is stateless, so we want to use a "session protocol" on top of it
- There's no such thing as a "session protocol"
- Implemented at application layer instead
  - State maintained in session variables
  - Data stored in one request can be accessed by later request

- Application layer sessions are one reason to use a web framework
  - Flask, Django, Ruby-on-rails, etc.

Server session model

- Sessions are explicitly opened and closed by the server

- When to create a session?
- How to store session data?
- When to close a session?
- How to link sessions to users?
- How to link HTTP requests to a session?

When to create a session?

- Depends on the application
- Amazon?
  - When you visit the page
  - Needed for a shopping cart
- Gmail?
  - When you log in
  - Needed so that it shows the right mail to the right person

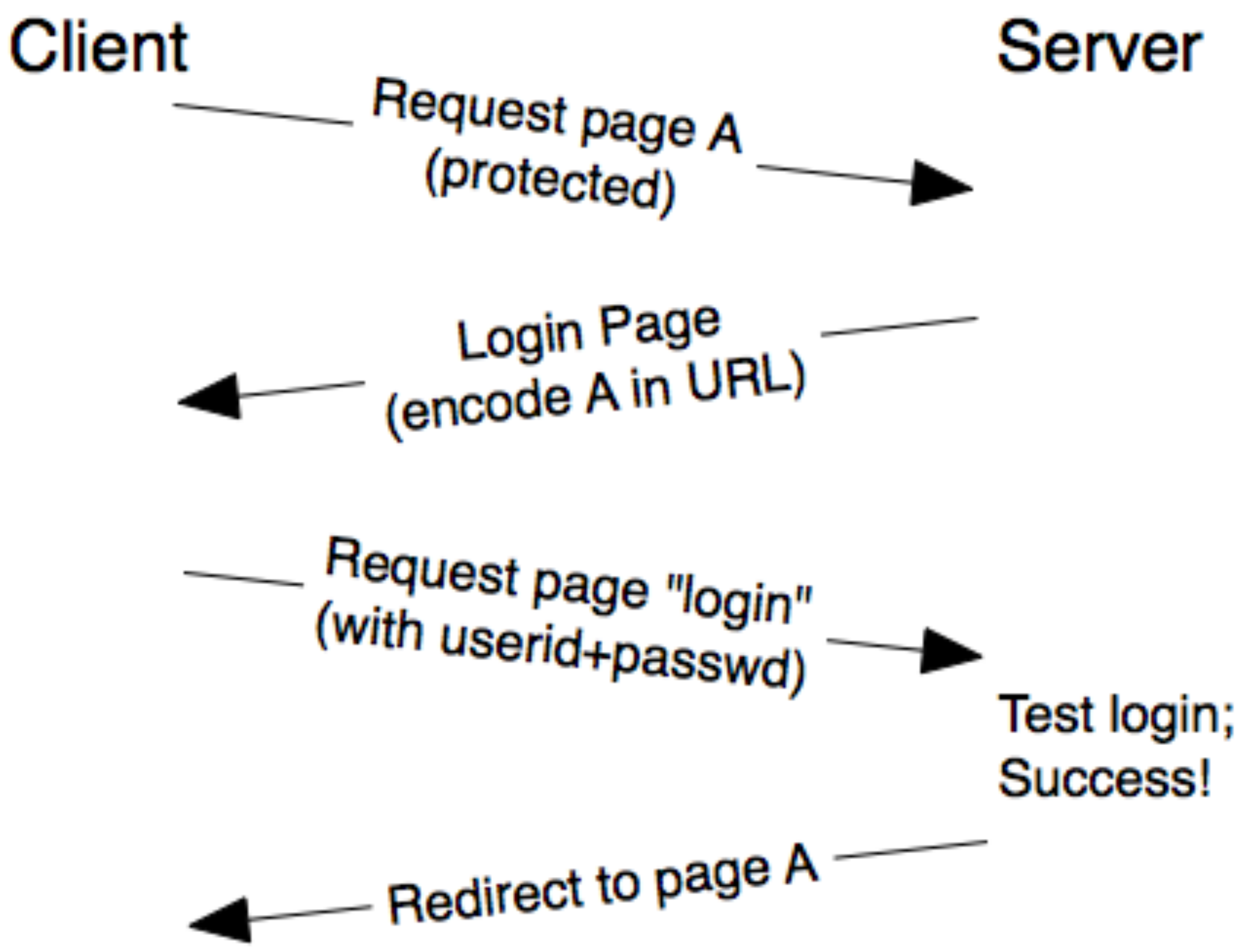
How to store session data?

- Session data storage is up to the server
- Best practice: store a small amount of data identify the session
  - Username, session ID, etc.
- Use session ID or username to do a database lookup
  - Shopping cart content, news feed items, etc.

When to close a session?

- We can't rely on logout
- Timeouts needed for almost all apps
  - When should the online game be reset?
  - When should Google forget your search?
  - When has your cart been abandoned?
  - When have you started searching for a different flight?
- Timeout from first request or most recent?

How to link sessions to users


Client
Server
Request page A (protected)
Login Page (encode A in URL)
Request page "login" (with userid+passwd)
Test login; Success!
Redirect to page A

How to link sessions to users

1. Client requests https://mail.google.com
2. Server responds with redirect to https://accounts.google.com/signin/v2/identifier?**continue=https%3A%2F%2Fmail.google.com%2Fmail%2F**
   - Recall URL escaping: `%3A` == `:`, `%2F` == `/`
3. Client sends request with username and password
4. Server tests and responds with redirect to https://mail.google.com

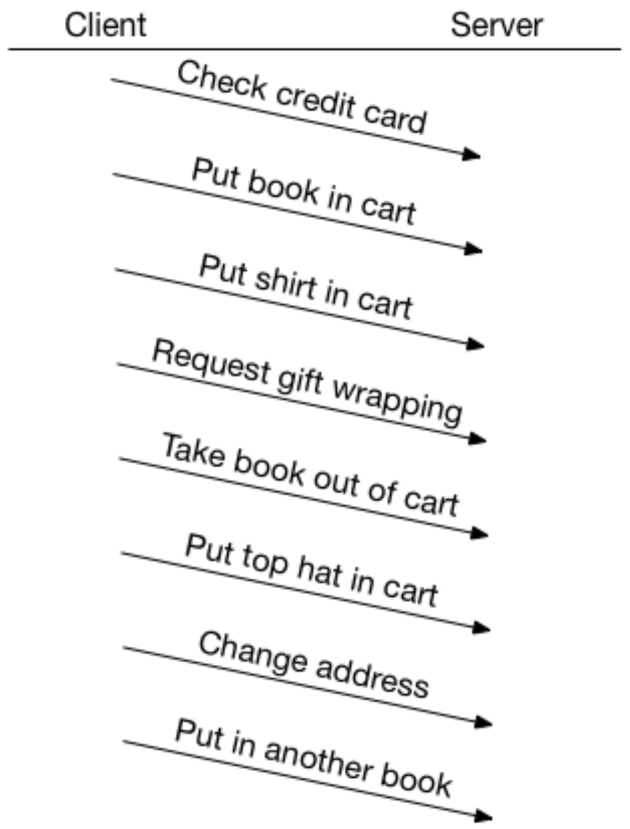
Agenda

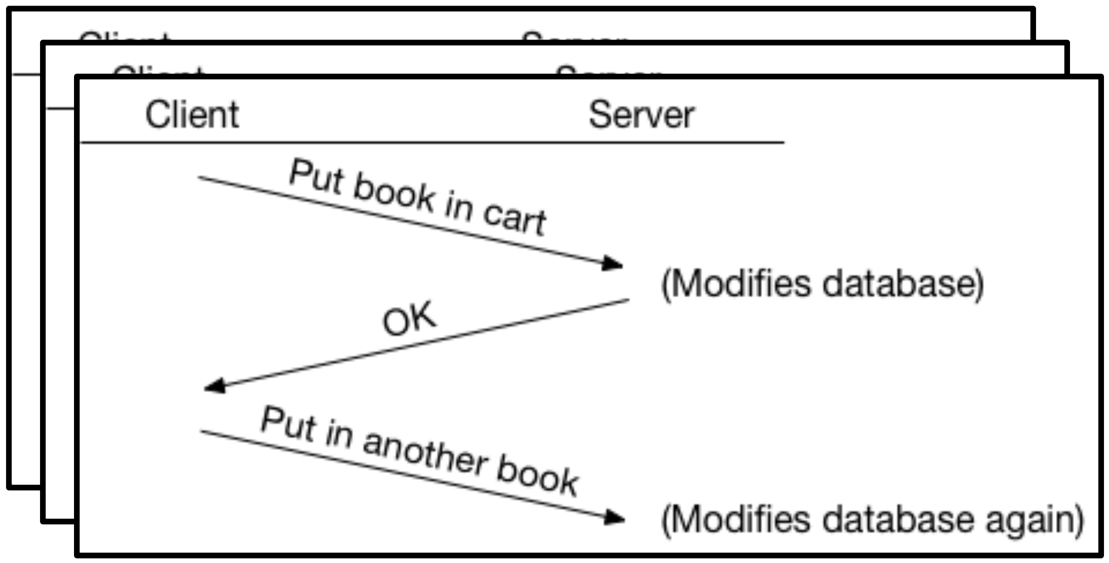
- Sessions
- **Cookies**
- Third-party cookies
- Example from project 2

Session implementation

- How to link HTTP requests to a session?

Turn this ... into this





Cookies

Cookie Monster
@MeCookieMonster

Me heard of something called “computer cookie”! How can me get one? Me bet it delicious!

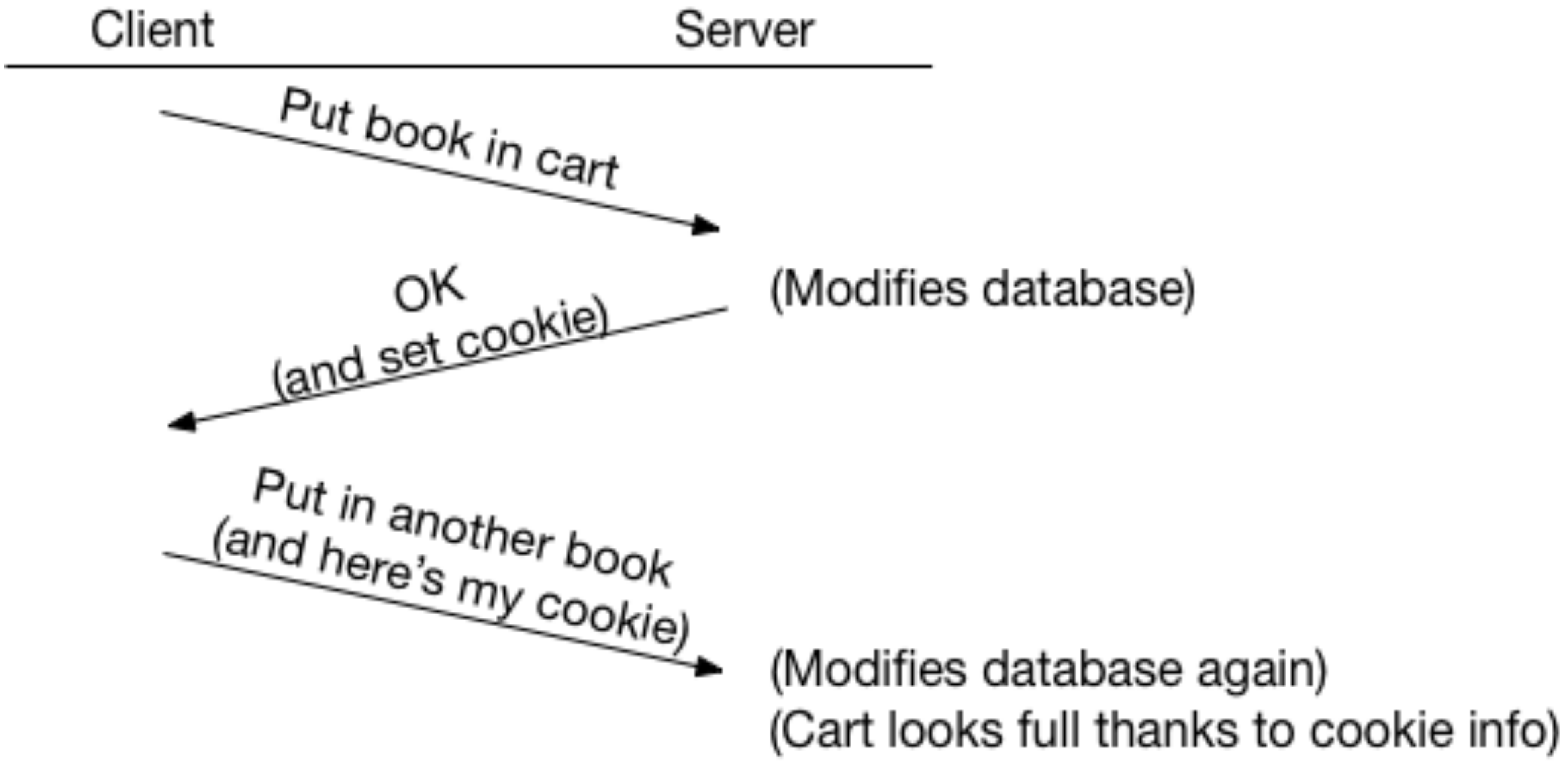
RETWEETS 280
LIKES 389

7:42 AM - 13 Jan 2016

- Cookies are small files on client machine
  - Carry state between HTTP requests
  - Contain key/value pairs

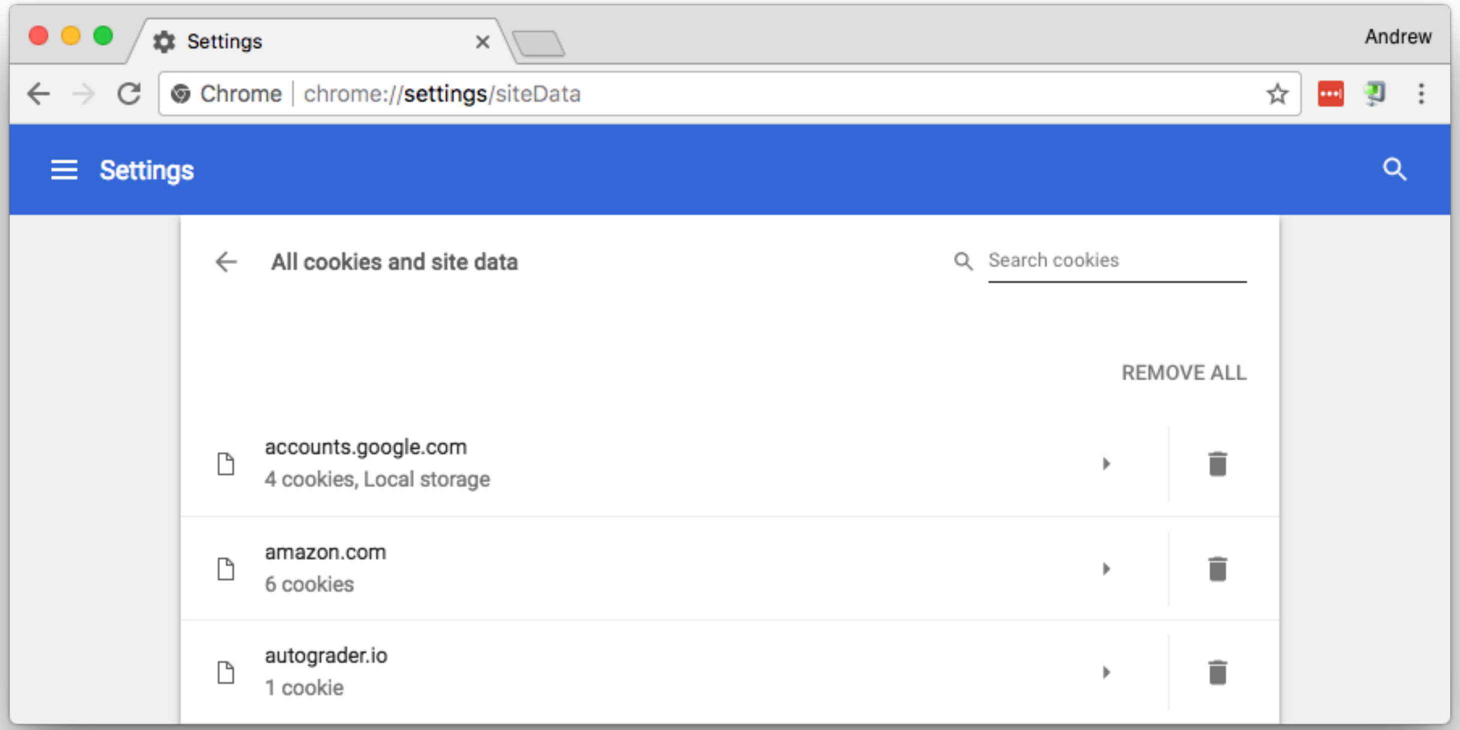
- According to the lore, the name originates from the story of Hansel and Gretel, who were able to mark their trail through a dark forest by dropping cookie crumbs behind them.

Cookies


Client
Server
Put book in cart
OK
(and set cookie)
(Modifies database)
Put in another book
(and here's my cookie)
(Modifies database again)
(Cart looks full thanks to cookie info)

Example: cookies in Chrome

- See all cookies by browsing to `chrome://settings/siteData`
- Take a look at the cookies on your own laptop


Settings
Andrew
Chrome | chrome://settings/siteData
Settings
All cookies and site data
Search cookies
REMOVE ALL

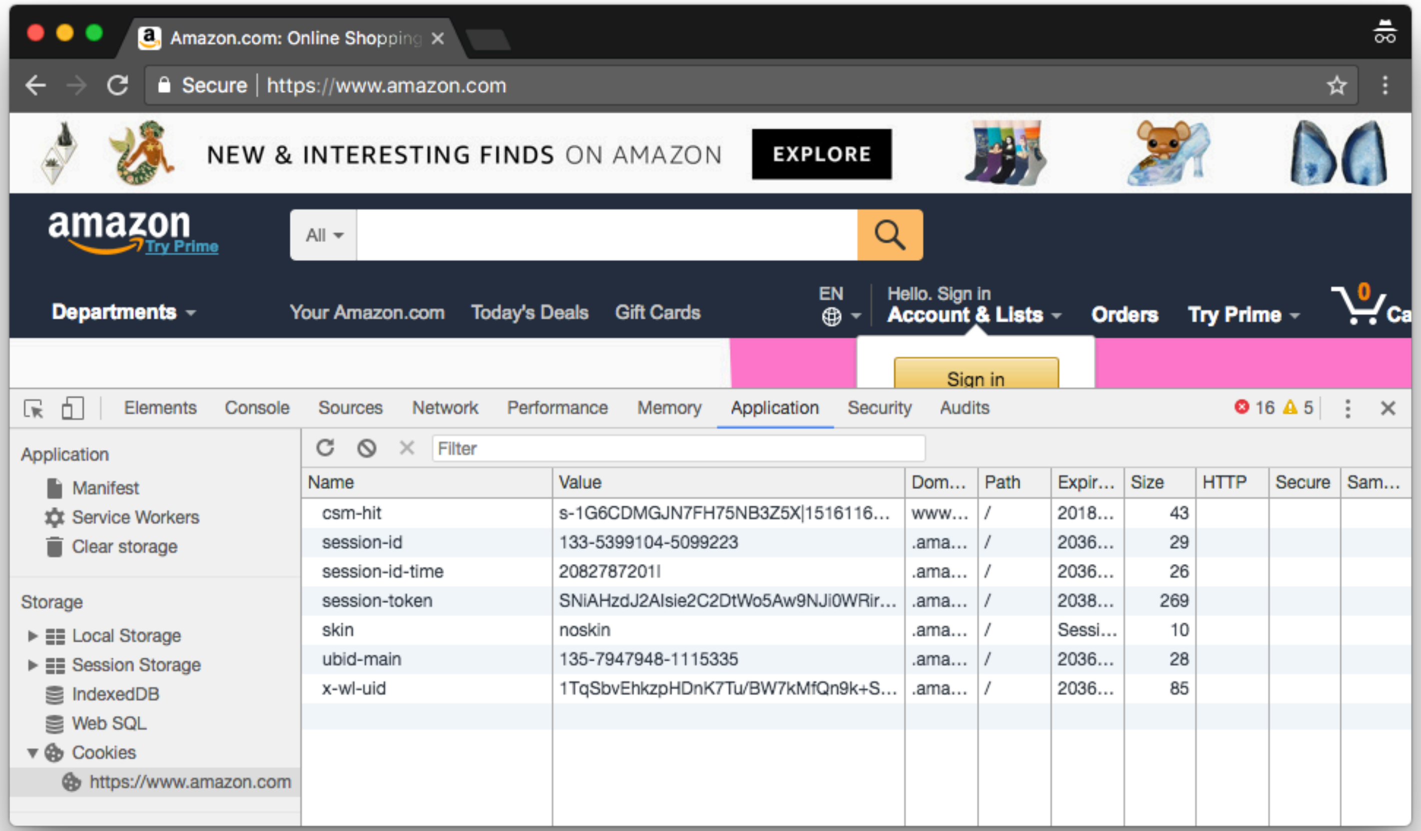
accounts.google.com
4 cookies, Local storage

amazon.com
6 cookies

autograder.io
1 cookie

Example: cookies in Chrome

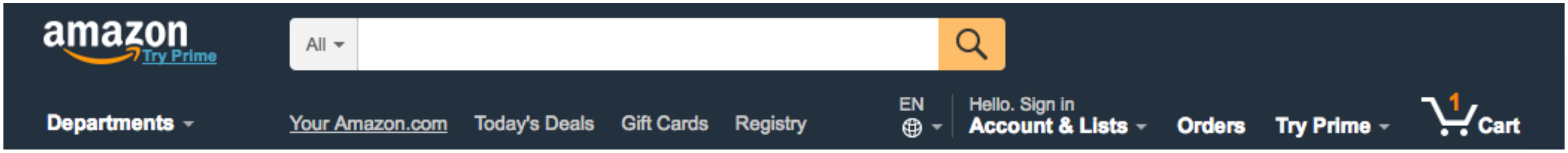
- Browse to https://www.amazon.com/
- Settings / Advanced / Content settings / Cookies / See all cookies

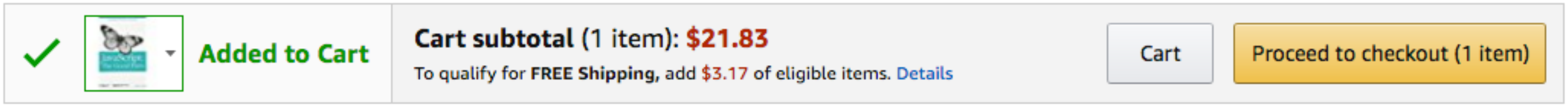


Name	Value	Dom...	Path	Expir...	Size	HTTP	Secure	Sam...
csm-hit	s-1G6CDMGJN7FH75NB3Z5X|1516116...	www...	/	2018...	43			
session-id	133-5399104-5099223	.ama...	/	2036...	29			
session-id-time	2082787201l	.ama...	/	2036...	26			
session-token	SNiAHzdJ2Alsie2C2DtWo5Aw9NJi0WRir...	.ama...	/	2038...	269			
skin	noskin	.ama...	/	Sessi...	10			
ubid-main	135-7947948-1115335	.ama...	/	2036...	28			
x-wl-uid	1TqSbvEhkzpHDnK7Tu/BW7kMfQn9k+S...	.ama...	/	2036...	85			

Example: shopping cart

- Browse to https://www.amazon.com/
- Add something to the cart

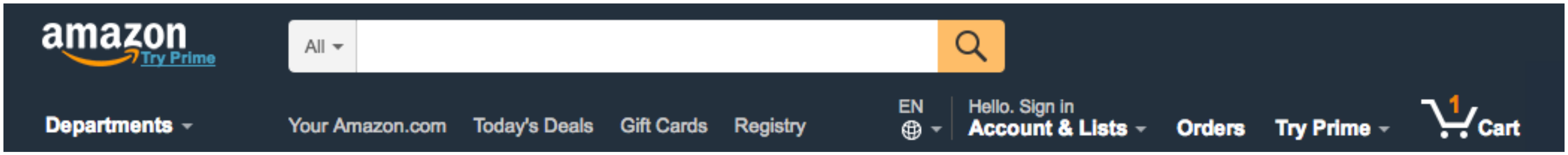




Cart subtotal (1 item): **$21.83**
To qualify for **FREE Shipping**, add $3.17 of eligible items. Details

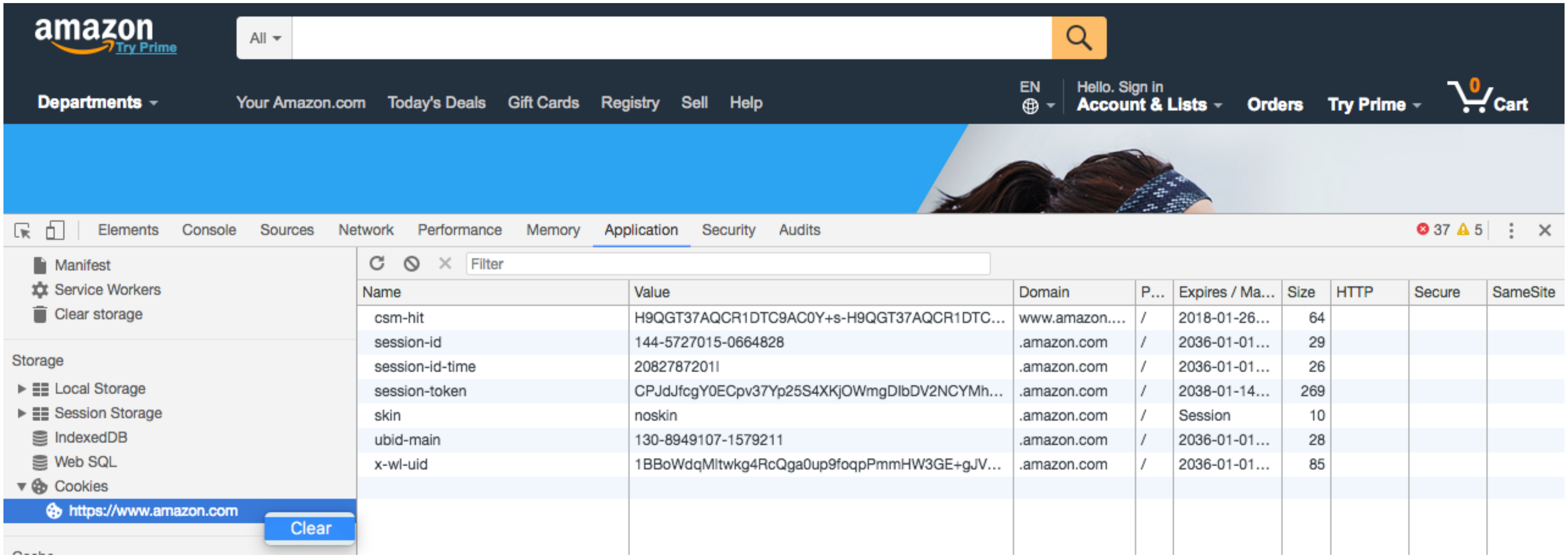
Example: shopping cart

- Again, browse to https://www.amazon.com/
- Cart has one item, even though we're on a different page



Example: shopping cart

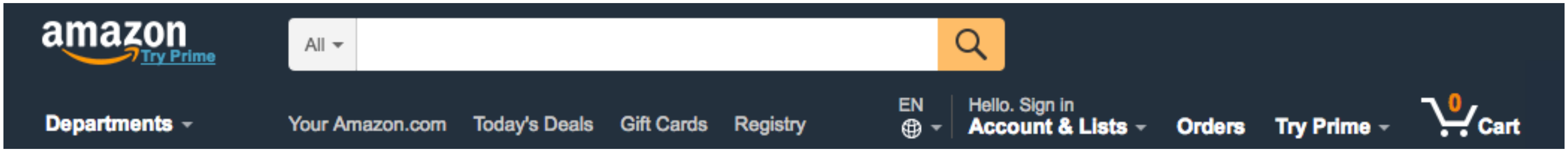
- Clear cookies using the developer console



Name	Value	Domain	P...	Expires / Ma...	Size	HTTP	Secure	SameSite
csm-hit	H9QGT37AQCR1DTC9AC0Y+s-H9QGT37AQCR1DTC...	www.amazon....	/	2018-01-26...	64			
session-id	144-5727015-0664828	.amazon.com	/	2036-01-01...	29			
session-id-time	2082787201l	.amazon.com	/	2036-01-01...	26			
session-token	CPJdJfcgY0ECpv37Yp25S4XKjOWmgDlbDV2NCYMh...	.amazon.com	/	2038-01-14...	269			
skin	noskin	.amazon.com	/	Session	10			
ubid-main	130-8949107-1579211	.amazon.com	/	2036-01-01...	28			
x-wl-uid	1BBoWdqMltwkg4RcQga0up9foqpPmmHW3GE+gJV...	.amazon.com	/	2036-01-01...	85			

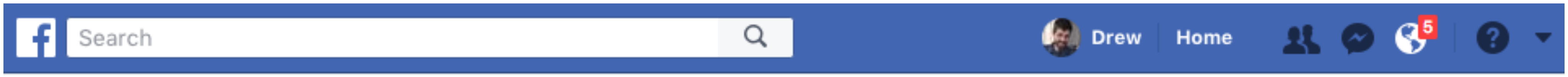
Example: shopping cart

- Again, browse to https://www.amazon.com/
- Cart appears empty

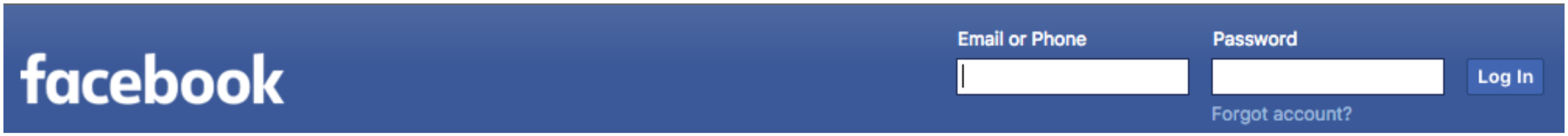


Example: facebook log in

- Log in Facebook (or any other web site)

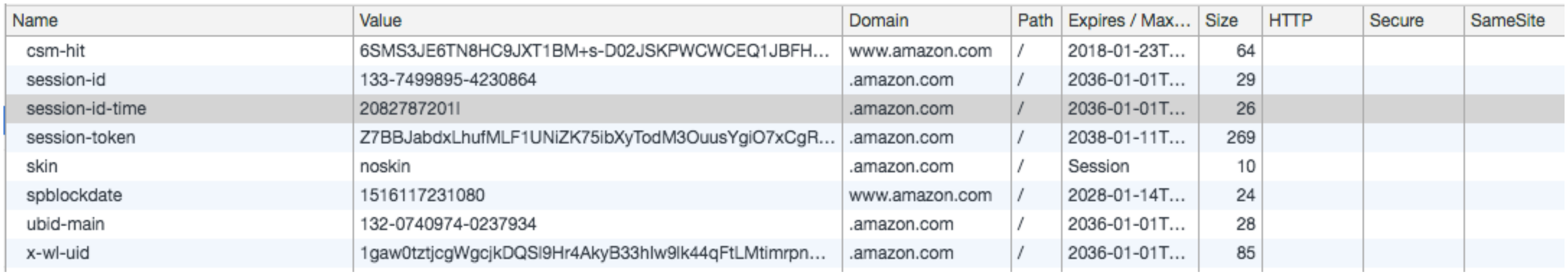


- Clear the Facebook cookies using the developer console
- Visit facebook.com again
- You’re no longer logged in



Cookie content

- **Name** is up to the server
- **Value** is up to server: encrypted? OK!
- **Domain** used by browser per-domain, total limits
- **Path** specifies scope of cookie
  - / vs. /cart/ or whatever
- **Expiration** tells client when to delete
- **Secure** is how cookie may be transmitted



Name	Value	Domain	Path	Expires / Max…	Size	HTTP	Secure	SameSite
csm-hit	6SMS3JE6TN8HC9JXT1BM+s-D02JSKPWCWCEQ1JBFH…	www.amazon.com	/	2018-01-23T…	64			
session-id	133-7499895-4230864	.amazon.com	/	2036-01-01T…	29			
session-id-time	2082787201l	.amazon.com	/	2036-01-01T…	26			
session-token	Z7BBJabdxLhufMLF1UNiZK75ibXyTodM3OuusYgiO7xCgR…	.amazon.com	/	2038-01-11T…	269			
skin	noskin	.amazon.com	/	Session	10			
spblockdate	1516117231080	www.amazon.com	/	2028-01-14T…	24			
ubid-main	132-0740974-0237934	.amazon.com	/	2036-01-01T…	28			
x-wl-uid	1gaw0tztjcgWgcjkDQSl9Hr4AkyB33hlw9lk44qFtLMtimrpn…	.amazon.com	/	2036-01-01T…	85			

Cookie content

- Cookies only over-writable by same domain and path
- Enforced by browser

- Store a username, session ID, etc. in the cookie
- Use session ID or username to do a database lookup
  - Shopping card content, news feed items, etc.

Cookie transfer

- Set by server, but not requested
- Sent by client, but never edited
- Either side can delete/ignore cookies

- Sent as part of HTTP headers

Cookie transfer

- Visit Amazon using `curl`
- Fake the user agent, pretend to be a web browser
  - `--user-agent "Mozilla/5.0"`
- Ignore the page itself, just look at the the headers
  - `> /dev/null`
- Curl sends `Host` and `User-Agent` headers to Amazon

```
$ curl --verbose --user-agent "Mozilla/5.0"
https://www.amazon.com/ > /dev/null
> GET / HTTP/1.1
> Host: www.amazon.com
> User-Agent: Mozilla/5.0
> Accept: */*
...
```

Cookie transfer

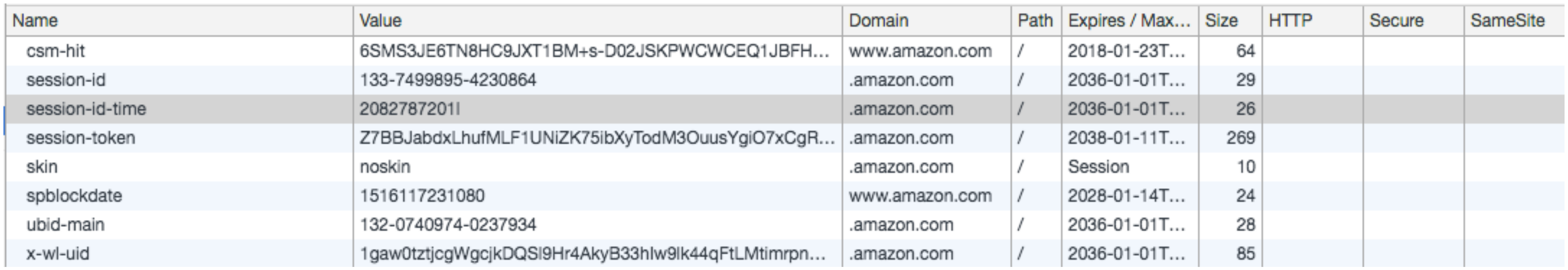
- Amazon responds with `200 OK`, some headers, and data

```
$ curl --verbose --user-agent "Mozilla/5.0"
https://www.amazon.com/ > /dev/null
...
< HTTP/1.1 200 OK
< Content-Type: text/html;charset=UTF-8
...
< Set-Cookie: skin=noskin; path=/; domain=.amazon.com
< Set-Cookie: session-id=130-5594428-2333702;
Domain=.amazon.com; Expires=Tue, 01-Jan-2036 08:00:01
GMT; Path=/
< Set-Cookie: session-id-time=20827872011;
Domain=.amazon.com; Expires=Tue, 01-Jan-2036 08:00:01
GMT; Path=/
```

Cookie transfer

- Headers include request to `Set-Cookie`
- These are exactly (some of) the cookies we saw in Chrome

```
$ curl --verbose --user-agent "Mozilla/5.0"
https://www.amazon.com/ > /dev/null
...
< Set-Cookie: skin=noskin; path=/; domain=.amazon.com
< Set-Cookie: session-id=130-5594428-2333702;
Domain=.amazon.com; Expires=Tue, 01-Jan-2036 08:00:01
GMT; Path=/
< Set-Cookie: session-id-time=2082787201l;
Domain=.amazon.com; Expires=Tue, 01-Jan-2036 08:00:01
GMT; Path=/
```



Name	Value	Domain	Path	Expires / Max...	Size	HTTP	Secure	SameSite
csm-hit	6SMS3JE6TN8HC9JXT1BM+s-D02JSKPWCWCEQ1JBFH...	www.amazon.com	/	2018-01-23T...	64			
session-id	133-7499895-4230864	.amazon.com	/	2036-01-01T...	29			
session-id-time	2082787201l	.amazon.com	/	2036-01-01T...	26			
session-token	Z7BBJabdxLhufMLF1UNiZK75ibXyTodM3OuusYgiO7xCgR...	.amazon.com	/	2038-01-11T...	269			
skin	noskin	.amazon.com	/	Session	10			
spblockdate	1516117231080	www.amazon.com	/	2028-01-14T...	24			
ubid-main	132-0740974-0237934	.amazon.com	/	2036-01-01T...	28			
x-wl-uid	1gaw0tztjcgWgcjkDQSl9Hr4AkyB33hlw9lk44qFtLMtimrpn...	.amazon.com	/	2036-01-01T...	85			

Cookie transfer

- Cookies add to HTTP overhead
- Again, best practice is to store a small amount of data in the cookie
- Use that data to do a database lookup on the server side

Saving cookies

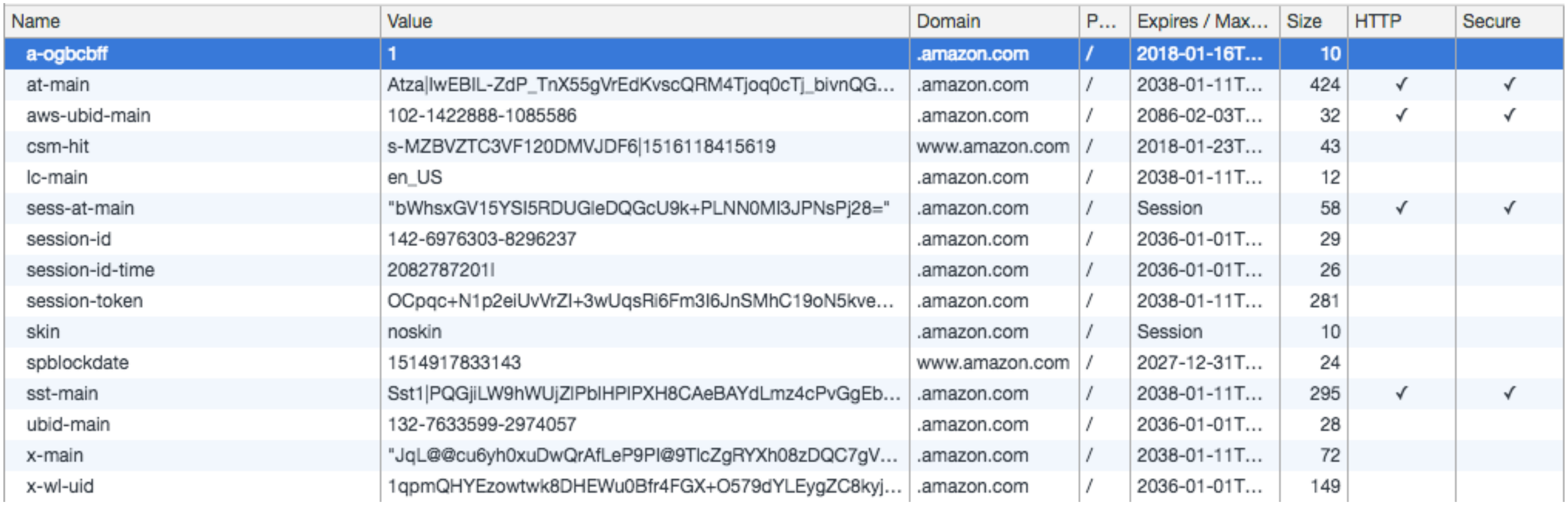
- Your browser saves cookies by default
- Tell `curl` to save cookies with `--cookie-jar`

```
$ curl --verbose --user-agent "Mozilla/5.0"
  --cookie-jar cookies.txt https://www.amazon.com/
  > /dev/null
```

```
$ cat cookies.txt
.amazon.com TRUE / FALSE 0 skin noskin
.amazon.com TRUE / FALSE 2082787201 session-id 147-
4402398-5757441
.amazon.com TRUE / FALSE 2082787201 session-id-time
2082787201l
```

Encrypted cookie transfer

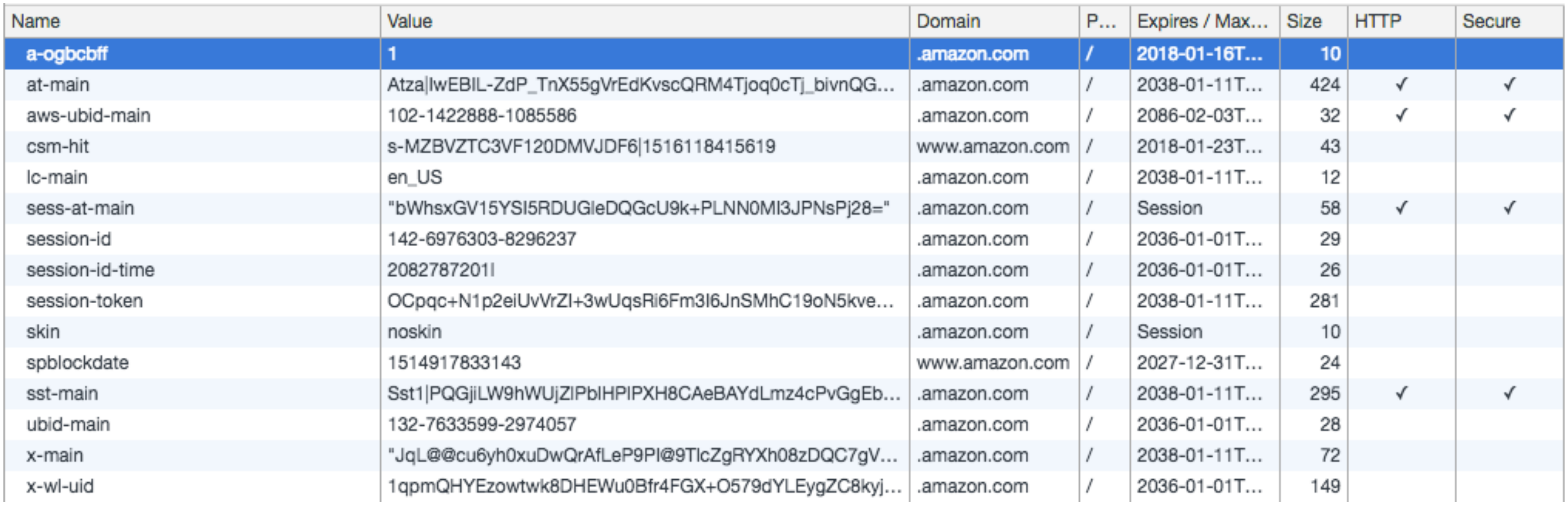
- If I have your cookies, I can steal your session
  - To the server, I look just like you!
- Prevent this with cookies that can only be transmitted over HTTPS



Name	Value	Domain	P...	Expires / Max...	Size	HTTP	Secure
a-ogbcbff	1	.amazon.com	/	2018-01-16T...	10		
at-main	Atza|IwEBIL-ZdP_TnX55gVrEdKvscQRM4Tjoq0cTj_bivnQG...	.amazon.com	/	2038-01-11T...	424	✓	✓
aws-ubid-main	102-1422888-1085586	.amazon.com	/	2086-02-03T...	32	✓	✓
csm-hit	s-MZBVZTC3VF120DMVJDF6|1516118415619	www.amazon.com	/	2018-01-23T...	43		
lc-main	en_US	.amazon.com	/	2038-01-11T...	12		
sess-at-main	"bWhsxGV15YSI5RDUGleDQGcU9k+PLNN0MI3JPNsPj28="	.amazon.com	/	Session	58	✓	✓
session-id	142-6976303-8296237	.amazon.com	/	2036-01-01T...	29		
session-id-time	2082787201l	.amazon.com	/	2036-01-01T...	26		
session-token	OCpqc+N1p2eiUvVrZI+3wUqsRi6Fm3I6JnSMhC19oN5kve...	.amazon.com	/	2038-01-11T...	281		
skin	noskin	.amazon.com	/	Session	10		
spblockdate	1514917833143	www.amazon.com	/	2027-12-31T...	24		
sst-main	Sst1|PQGjiLW9hWUjZIPbIHPIPXH8CAeBAYdLmz4cPvGgEb...	.amazon.com	/	2038-01-11T...	295	✓	✓
ubid-main	132-7633599-2974057	.amazon.com	/	2036-01-01T...	28		
x-main	"JqL@@cu6yh0xuDwQrAfLeP9PI@9TlcZgRYXh08zDQC7gV...	.amazon.com	/	2038-01-11T...	72		
x-wl-uid	1qpmQHYEzowtwk8DHEWu0Bfr4FGX+O579dYLEygZC8kyj...	.amazon.com	/	2036-01-01T...	149		

Encrypted cookie values

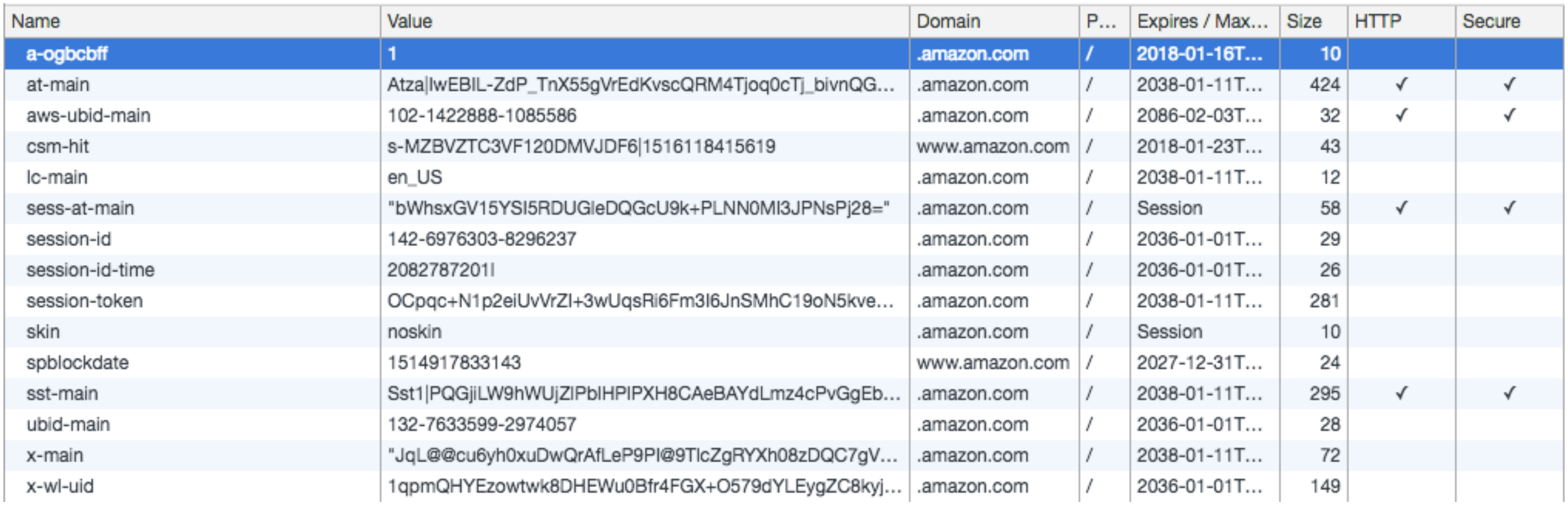
- If the client has a copy of cookies set by the server, then the client can manipulate the server
- Prevent this with encrypted cookie content
  - Only the server can decrypt



Name	Value	Domain	P...	Expires / Max...	Size	HTTP	Secure
a-ogbcbff	1	.amazon.com	/	2018-01-16T...	10		
at-main	Atza|IwEBIL-ZdP_TnX55gVrEdKvscQRM4Tjoq0cTj_bivnQG...	.amazon.com	/	2038-01-11T...	424	✓	✓
aws-ubid-main	102-1422888-1085586	.amazon.com	/	2086-02-03T...	32	✓	✓
csm-hit	s-MZBVZTC3VF120DMVJDF6|1516118415619	www.amazon.com	/	2018-01-23T...	43		
lc-main	en_US	.amazon.com	/	2038-01-11T...	12		
sess-at-main	"bWhsxGV15YSI5RDUGIeDQGcU9k+PLNN0MI3JPNsPj28="	.amazon.com	/	Session	58	✓	✓
session-id	142-6976303-8296237	.amazon.com	/	2036-01-01T...	29		
session-id-time	2082787201l	.amazon.com	/	2036-01-01T...	26		
session-token	OCpqc+N1p2eiUvVrZI+3wUqsRi6Fm3I6JnSMhC19oN5kve...	.amazon.com	/	2038-01-11T...	281		
skin	noskin	.amazon.com	/	Session	10		
spblockdate	1514917833143	www.amazon.com	/	2027-12-31T...	24		
sst-main	Sst1|PQGjiLW9hWUjZIPbIHPIPXH8CAeBAYdLmz4cPvGgEb...	.amazon.com	/	2038-01-11T...	295	✓	✓
ubid-main	132-7633599-2974057	.amazon.com	/	2036-01-01T...	28		
x-main	"JqL@@cu6yh0xuDwQrAfLeP9PI@9TlcZgRYXh08zDQC7gV...	.amazon.com	/	2038-01-11T...	72		
x-wl-uid	1qpmQHYEzowtwk8DHEWu0Bfr4FGX+O579dYLEygZC8kyj...	.amazon.com	/	2036-01-01T...	149		

Session vs. permanent cookies

- Session cookies are deleted by the client shuts down
  - Close the tab or quit the browser
- Permanent cookies have explicit expiration dates



Name	Value	Domain	P...	Expires / Max...	Size	HTTP	Secure
a-ogbcbff	1	.amazon.com	/	2018-01-16T...	10		
at-main	Atza|IwEBIL-ZdP_TnX55gVrEdKvscQRM4Tjoq0cTj_bivnQG...	.amazon.com	/	2038-01-11T...	424	✓	✓
aws-ubid-main	102-1422888-1085586	.amazon.com	/	2086-02-03T...	32	✓	✓
csm-hit	s-MZBVZTC3VF120DMVJDF6|1516118415619	www.amazon.com	/	2018-01-23T...	43		
lc-main	en_US	.amazon.com	/	2038-01-11T...	12		
sess-at-main	"bWhsxGV15YSI5RDUGIeDQGcU9k+PLNN0MI3JPNsPj28="	.amazon.com	/	Session	58	✓	✓
session-id	142-6976303-8296237	.amazon.com	/	2036-01-01T...	29		
session-id-time	2082787201l	.amazon.com	/	2036-01-01T...	26		
session-token	OCpqc+N1p2eiUvVrZI+3wUqsRi6Fm3I6JnSMhC19oN5kve...	.amazon.com	/	2038-01-11T...	281		
skin	noskin	.amazon.com	/	Session	10		
spblockdate	1514917833143	www.amazon.com	/	2027-12-31T...	24		
sst-main	Sst1|PQGjiLW9hWUjZIPbIHPIPXH8CAeBAYdLmz4cPvGgEb...	.amazon.com	/	2038-01-11T...	295	✓	✓
ubid-main	132-7633599-2974057	.amazon.com	/	2036-01-01T...	28		
x-main	"JqL@@cu6yh0xuDwQrAfLeP9PI@9TlcZgRYXh08zDQC7gV...	.amazon.com	/	2038-01-11T...	72		
x-wl-uid	1qpmQHYEzowtwk8DHEWu0Bfr4FGX+O579dYLEygZC8kyj...	.amazon.com	/	2036-01-01T...	149		

Agenda

- Sessions
- Cookies
- **Third-party cookies**
- Example from project 2

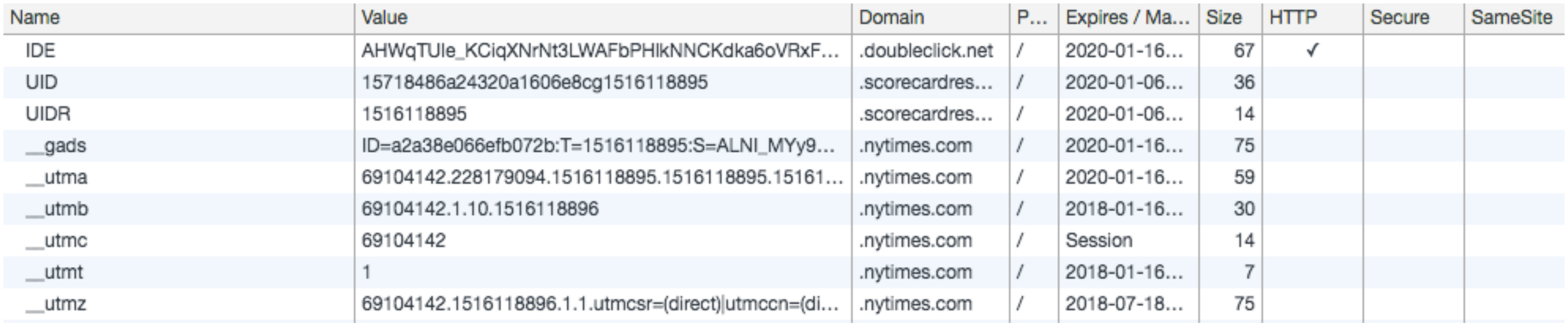
Third-party cookies

- Page may contain objects from many sources
  - Scripts, images, etc.
- These 3rd-party objects set and get cookies
- Example: nytimes.com

```
<html>
  <head>
    <script
      src="https://tags.bluekai.com/site/50550?ret=js&limit=1"
      type="text/javascript"
    >
    </script>
  </head>
  <body>
    <img src="https://static01.nyt.com/newsgraphics/2018/01/18/shutdown-
deal-factions/assets/images/lindsey-graham.png">
  </body>
</html>
```

Third-party cookies

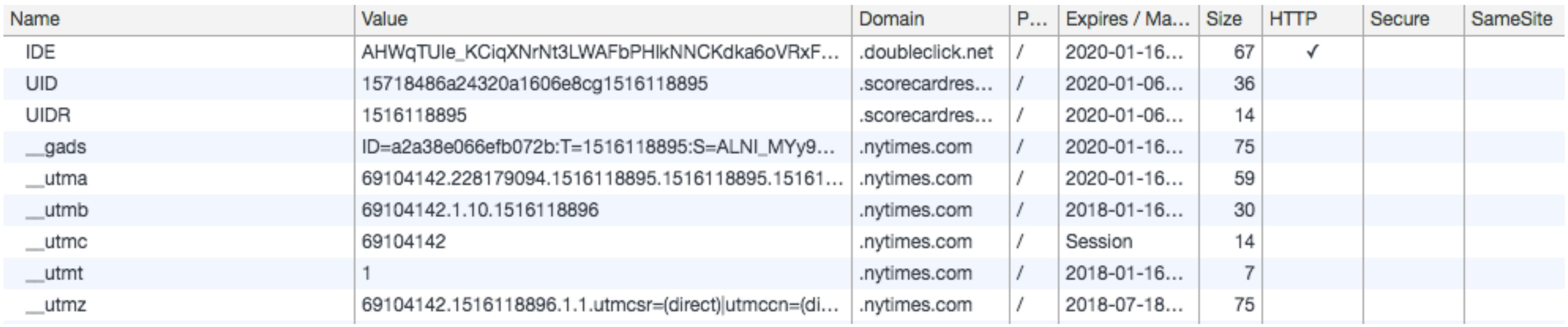
- Cookies have a domain
- *First-party cookie*: domain is the same as the domain of the page you are on
- *Third-party cookie*: domain is different
- Example from nytimes.com



Name	Value	Domain	P...	Expires / Ma...	Size	HTTP	Secure	SameSite
IDE	AHWqTUle_KCiqXNrNt3LWAFbPHlkNNCKdka6oVRxF...	.doubleclick.net	/	2020-01-16...	67	✓		
UID	15718486a24320a1606e8cg1516118895	.scorecardres...	/	2020-01-06...	36			
UIDR	1516118895	.scorecardres...	/	2020-01-06...	14			
__gads	ID=a2a38e066efb072b:T=1516118895:S=ALNI_MYy9...	.nytimes.com	/	2020-01-16...	75			
__utma	69104142.228179094.1516118895.1516118895.15161...	.nytimes.com	/	2020-01-16...	59			
__utmb	69104142.1.10.1516118896	.nytimes.com	/	2018-01-16...	30			
__utmc	69104142	.nytimes.com	/	Session	14			
__utmt	1	.nytimes.com	/	2018-01-16...	7			
__utmz	69104142.1516118896.1.1.utmcsr=(direct)|utmccn=(di...	.nytimes.com	/	2018-07-18...	75			

Example: Google third party cookies

- One of the main advertising cookies on non-Google sites is named `IDE` and is stored in browsers under the domain `doubleclick.net`.
  - https://www.google.com/policies/technologies/types/
- Visit nytimes.com and view cookies:



Name	Value	Domain	P...	Expires / Ma...	Size	HTTP	Secure	SameSite
IDE	AHWqTUIe_KCiqXNrNt3LWAFbPHlkNNCKdka6oVRxF...	.doubleclick.net	/	2020-01-16...	67	✓		
UID	15718486a24320a1606e8cg1516118895	.scorecardres...	/	2020-01-06...	36			
UIDR	1516118895	.scorecardres...	/	2020-01-06...	14			
__gads	ID=a2a38e066efb072b:T=1516118895:S=ALNI_MYy9...	.nytimes.com	/	2020-01-16...	75			
__utma	69104142.228179094.1516118895.1516118895.15161...	.nytimes.com	/	2020-01-16...	59			
__utmb	69104142.1.10.1516118896	.nytimes.com	/	2018-01-16...	30			
__utmc	69104142	.nytimes.com	/	Session	14			
__utmt	1	.nytimes.com	/	2018-01-16...	7			
__utmz	69104142.1516118896.1.1.utmcsr=(direct)|utmccn=(di...	.nytimes.com	/	2018-07-18...	75			

Example: Google third party cookies

- Excerpt from nytimes.com HTML source

```
<html>
  <body>
    ...
    <script>
     function placeGpt() {
       var gptScript = document.createElement('script');
       gptScript.src = '//securepubads.g.doubleclick.net/tag/js/gpt.js';
       document.head.appendChild(gptScript);
     }
     placeGpt()
    </script>
  </body>
</html>
```

Example: Google third party cookies

- You type nytimes.com into your browser
- Browser issues `GET` request to nytimes.com
    - Includes nytimes.com cookies
- Browser receives HTML for nytimes.com
    - HTML includes some JavaScript via the `<script>` tag
- Browser executes JavaScript included by nytimes.com
    - JS code figures out you are on nytimes.com, e.g., with `window.location.href`
    - JS codes initiates a request to doubleclick.net
- Browser issues `GET` request to doubleclick.net
    - Includes doubleclick.net cookie
    - Appends your current location (nytimes.com) to the URL
- Now, doubleclick.net (AKA Google) knows you visited nytimes.com

Who uses third-party cookies?

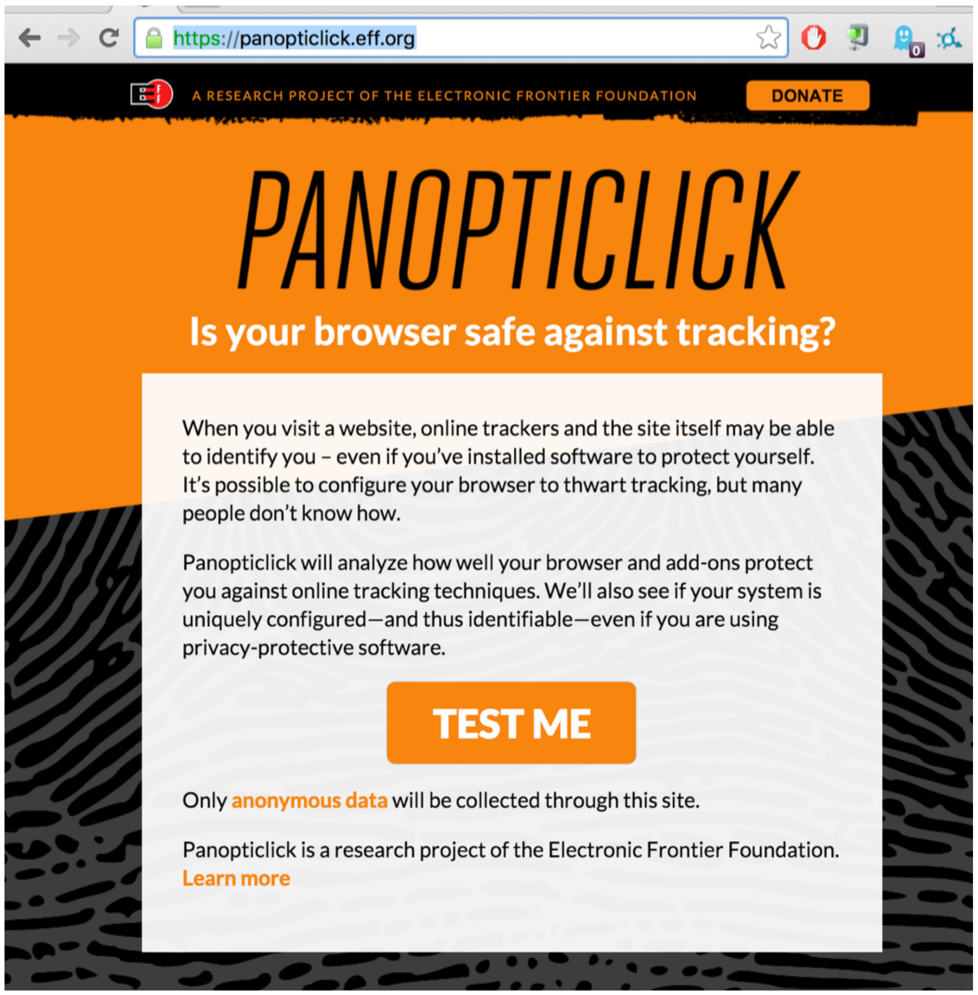
- Companies that sell ads directly
  - Google and Facebook (obviously)
- Companies that sell information about you
  - Acxiom "one of the biggest companies you've never heard of" ($1B+)
- “If you're not paying for the product, then you *are* the product”
  - That's mostly how the business side of the web is structured

What does Acxiom have on me?

- You can view part of the profile Acxiom has on you
- ....
- But to see it, you need to give them your name, address, email, social security number ...

Checking what you send to trackers

- https://panopticlick.eff.org/


https://panopticlick.eff.org
A RESEARCH PROJECT OF THE ELECTRONIC FRONTIER FOUNDATION
DONATE
PANOPTICLICK

Is your browser safe against tracking?

When you visit a website, online trackers and the site itself may be able to identify you – even if you've installed software to protect yourself. It's possible to configure your browser to thwart tracking, but many people don't know how.

Panopticlick will analyze how well your browser and add-ons protect you against online tracking techniques. We'll also see if your system is uniquely configured—and thus identifiable—even if you are using privacy-protective software.

Only anonymous data will be collected through this site.

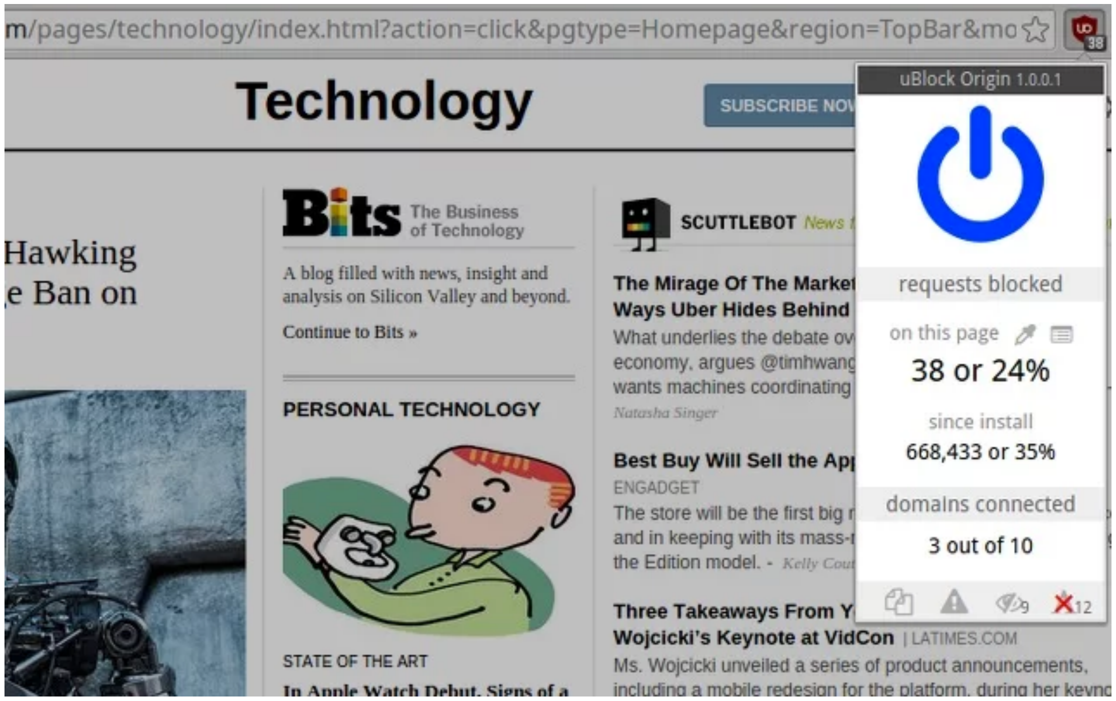
Panopticlick is a research project of the Electronic Frontier Foundation. Learn more

Browser fingerprinting

- Browser fingerprinting attempts to uniquely identify your browser using information other than cookies
  - User Agent
  - Time zone
  - Fonts
  - Language
  - And lots more
- Anti-fingerprinting options announced by Firefox, Chrome, Safari
  - As of fall 2019

Avoiding trackers

- Add-ons like uBlock Origin, Privacy Badger, Brave, Disconnect or ScriptNo block trackers
- Monitors embedded links and blacklists trackers



A blog filled with news, insight and analysis on Silicon Valley and beyond.

Continue to Bits »

In Apple Watch Debut, Signs of a

The Mirage Of The Market Ways Uber Hides Behind

What underlies the debate ov economy, argues @timhwang wants machines coordinating

Natasha Singer

Best Buy Will Sell the App

ENGADGET

The store will be the first big r and in keeping with its mass- the Edition model. - *Kelly Cou*

Three Takeaways From Y Wojcicki's Keynote at VidCon | LATIMES.COM

Ms. Wojcicki unveiled a series of product announcements, including a mobile redesign for the platform, during her keyno

requests blocked

on this page
38 or 24%

since install
668,433 or 35%

domains connected
3 out of 10

Discussion

- Many web companies make their money from information about users
- In exchange, they give you a "free" service (email, web search, a platform for gossip, etc.)
- Is it OK to block trackers?

Agenda

- Sessions
- Cookies
- Third-party cookies
- **Example from project 2**

Cookie example

Key idea: cookie is a bunch of key/value pairs. Flask provides them in a dictionary called `flask.session`

```
import flask
app = flask.Flask(__name__)

app.secret_key = b'uAy\x9d\x08[\x12\x8d\x9d\x1f\xbar\x86A\x9fpQy4\x05)v04'

@app.route('/')
def index():
    if "user" in flask.session:
        user = flask.session["user"]
        app.logger.debug("Get user=%s", user)
        return "<html><body>Hello {}</body></html>".format(user)
    else:
        flask.session["user"] = "awdeorio"
        app.logger.debug("Set user=%s", user)
        return "<html><body>Logging in ...</body></html>"

if __name__ == '__main__':
    app.run(debug=True)
```

Test if key exists

Get key/value

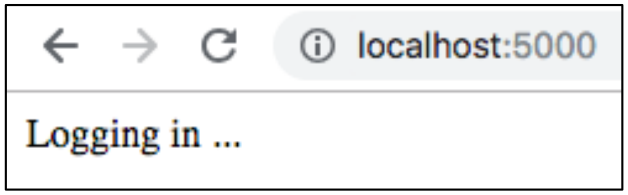
Set key/value

Cookie example

- Start server

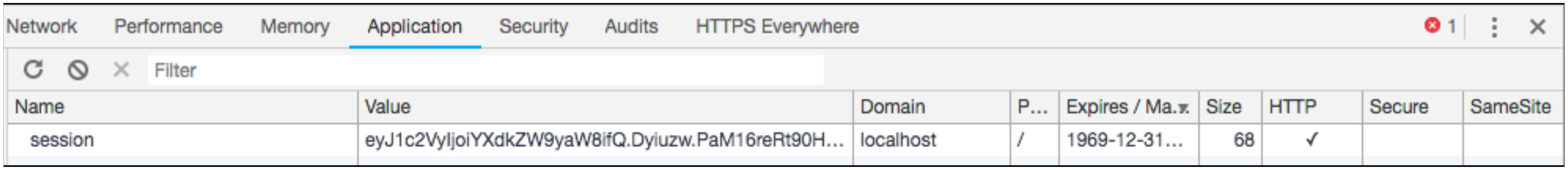
```
$ python3 test.py
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
[2019-01-22 08:40:31,790] DEBUG in test: Set user=awdeorio
127.0.0.1 - - [22/Jan/2019 08:40:31] "GET / HTTP/1.1" 200 -
```

- Browse to http://localhost:5000/



Logging in ...

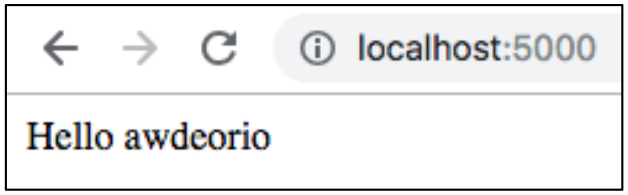
- See encrypted cookie in developer console



Name	Value	Domain	P...	Expires / Ma...	Size	HTTP	Secure	SameSite
session	eyJ1c2VyIjoiYXdkZW9yaW8ifQ.Dyiuzw.PaM16reRt90H...	localhost	/	1969-12-31...	68	✓		

Cookie example

- Hit refresh



Hello awdeorio

- Checker server logs. User read from encrypted cookie.

```
$ python3 test.py
 * Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
[2019-01-22 08:40:31,790] DEBUG in test: Set user=awdeorio
127.0.0.1 - - [22/Jan/2019 08:40:31] "GET / HTTP/1.1" 200 -
[2019-01-22 08:51:20,506] DEBUG in test: Get user=awdeorio
127.0.0.1 - - [22/Jan/2019 08:51:20] "GET / HTTP/1.1" 200 -
```

Cookie encryption key

```
import flask
app = flask.Flask(__name__)

app.secret_key = b'uAy\x9d\x08[\x12\x8d\x9d\x1f\xbar\x86A\x9fpQy4\x05)v04'

# ...
```

- Session cookies are encrypted
- The server has the encryption key

Cookie encryption key

- How to generate a secure encryption key?

- Need a cryptographically secure random number.
  - If a "random" number is in any way predictable, then a hacker could guess it and masquerade as any user!

- Generate a Python string

-
  ```
  $ python3 -c "import os; print(os.urandom(24))"
  b'uAy\x9d\x08[\x12\x8d\x9d\x1f\xbar\x86A\x9fpQy4\x05)v04'
  ```

Further reading

- Good reference on cookies
- https://developer.mozilla.org/en-US/docs/Web/HTTP/Cookies