APIs
Intro

HELLO

my name is

Scott

@sckott / @ropensci / @pdxrlang

Outline

1. What is an API?
2. HTTP
3. HTTP verbs
4. HTTP structure
5. Data formats
6. Wrap up

What is an API?

An API is…

Programmatic instructions for how to interact with a piece of software

Can be the interface to:

- A software package in R/Python/etc.
- A public web API
- A database
- An operating system

Most APIs are REST APIs

REST? WTF?

Representational **S**tate **T**ransfer

an architectural style in which most web APIs are constructed

https://en.wikipedia.org/wiki/Representational_state_transfer

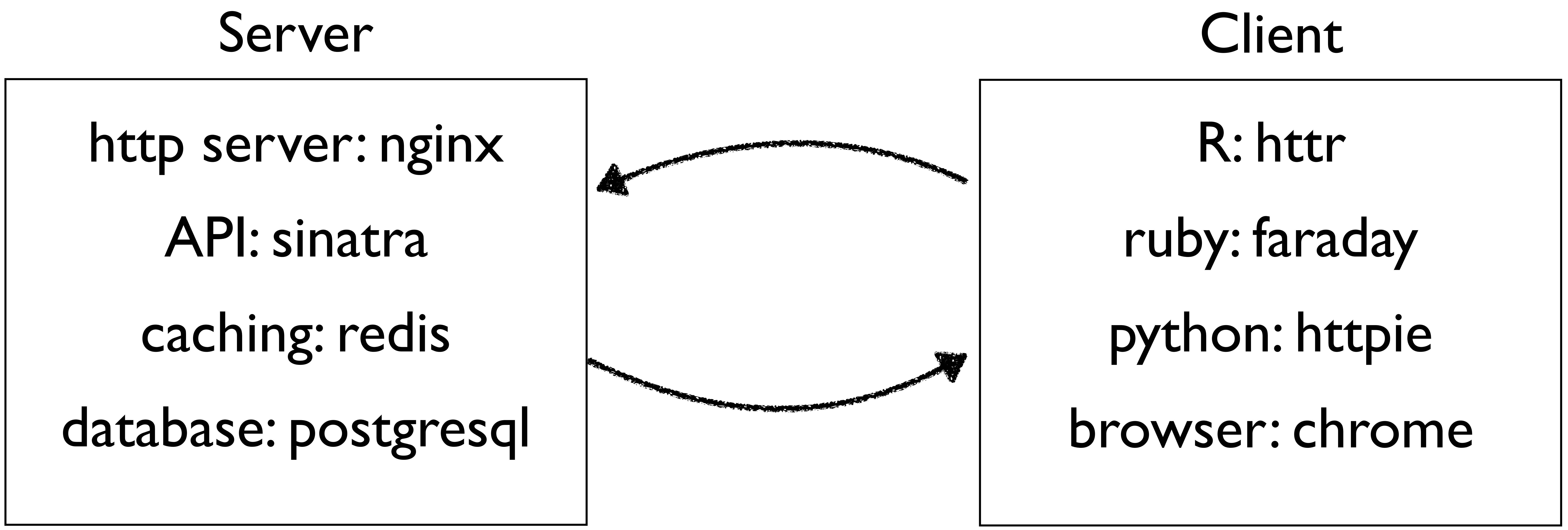
HTTP

Hyper**T**ext **T**ransfer **P**rotocol

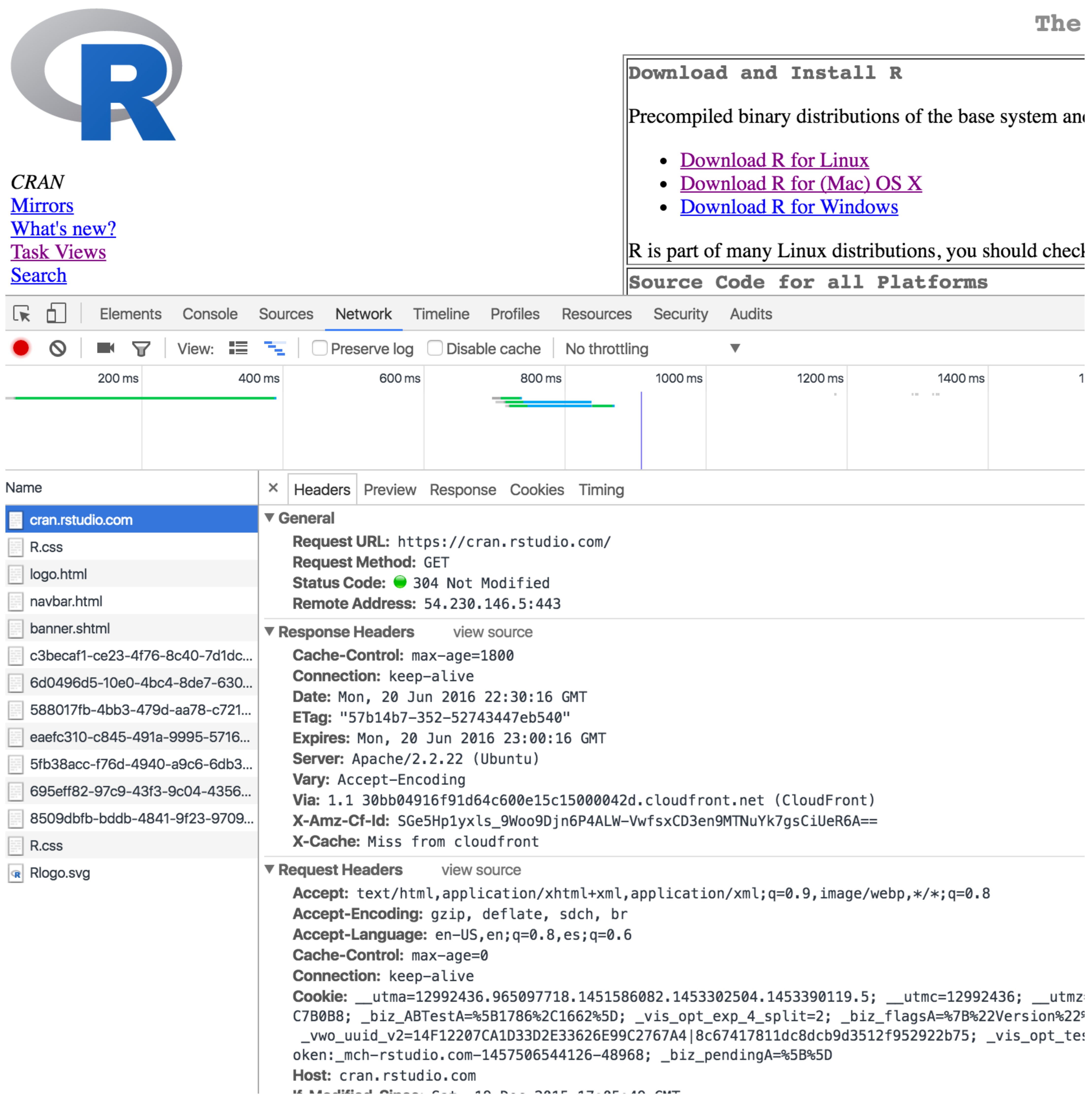
HTTP spec: https://tools.ietf.org/html/rfc7235

- Verbs for different actions
- Authentication
- Status codes
- Request and response format
- Most REST APIs use HTTP for data transfer

But, what does it all look like?



HTTP is behind the scenes



CRAN
Mirrors
What's new?
Task Views
Search

The

Download and Install R

Precompiled binary distributions of the base system an

- Download R for Linux
- Download R for (Mac) OS X
- Download R for Windows

R is part of many Linux distributions, you should chec

Source Code for all Platforms

```
cran.rstudio.com
R.css
logo.html
navbar.html
banner.shtml
c3becaf1-ce23-4f76-8c40-7d1dc...
6d0496d5-10e0-4bc4-8de7-630...
588017fb-4bb3-479d-aa78-c721...
eaefc310-c845-491a-9995-5716...
5fb38acc-f76d-4940-a9c6-6db3...
695eff82-97c9-43f3-9c04-4356...
8509dbfb-bddb-4841-9f23-9709...
R.css
Rlogo.svg
```

```
▼ General
    Request URL: https://cran.rstudio.com/
    Request Method: GET
    Status Code: ● 304 Not Modified
    Remote Address: 54.230.146.5:443
▼ Response Headers      view source
    Cache-Control: max-age=1800
    Connection: keep-alive
    Date: Mon, 20 Jun 2016 22:30:16 GMT
    ETag: "57b14b7-352-52743447eb540"
    Expires: Mon, 20 Jun 2016 23:00:16 GMT
    Server: Apache/2.2.22 (Ubuntu)
    Vary: Accept-Encoding
    Via: 1.1 30bb04916f91d64c600e15c15000042d.cloudfront.net (CloudFront)
    X-Amz-Cf-Id: SGe5Hp1yxls_9Woo9Djn6P4ALW-VwfsxCD3en9MTNuYk7gsCiUeR6A==
    X-Cache: Miss from cloudfront
▼ Request Headers      view source
    Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8
    Accept-Encoding: gzip, deflate, sdch, br
    Accept-Language: en-US,en;q=0.8,es;q=0.6
    Cache-Control: max-age=0
    Connection: keep-alive
    Cookie: __utma=12992436.965097718.1451586082.1453302504.1453390119.5; __utmc=12992436; __utmz
    C7B0B8; _biz_ABTestA=%5B1786%2C1662%5D; _vis_opt_exp_4_split=2; _biz_flagsA=%7B%22Version%22
     _vwo_uuid_v2=14F12207CA1D33D2E33626E99C2767A4|8c67417811dc8dcb9d3512f952922b75; _vis_opt_te
    oken:_mch-rstudio.com-1457506544126-48968; _biz_pendingA=%5B%5D
    Host: cran.rstudio.com
```

HTTP in R

You've been using HTTP in R - For example:

- install.packages() -> uses download.file() under the hood -> which uses http

Your Turn

httr hello world

- Load **httr**
- Use **httr::GET()** to get data from any website.
    - Poke around at the resulting object.
    - Find the *headers*, the *status code*, and the *content*

03:00

```r
library(httr)
x <- GET('https://google.com/')

x$status_code
#>[1] 200

x$headers
#> $date
#> [1] "Thu, 23 Jun 2016 23:05:27 GMT”
#> ...

x$content
#>[1] 3c 21 64 6f 63 74 79 70 65 20 68 ...
```

HTTP Verbs & Requests

HTTP Verbs

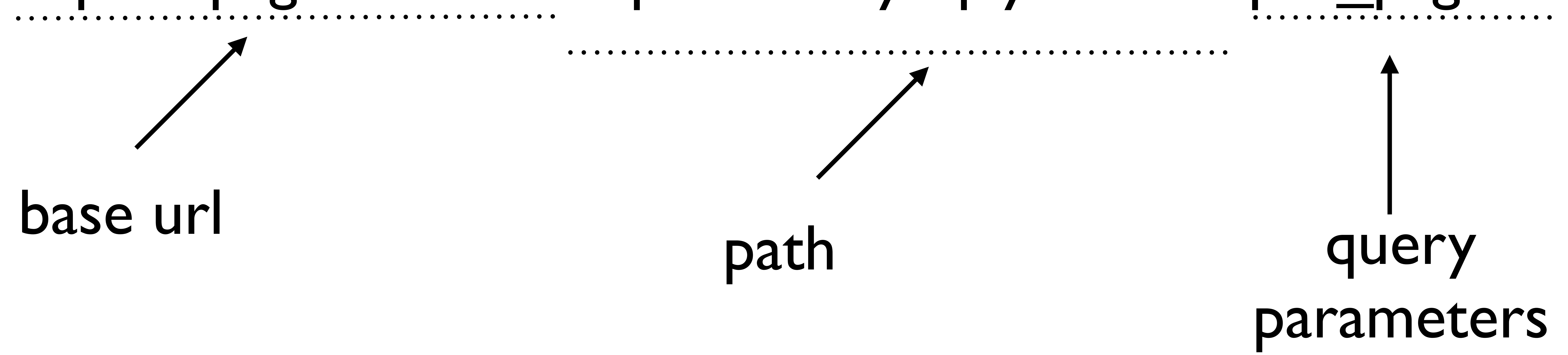
GET	Read
POST	Create
PUT	Update
DELETE	Delete

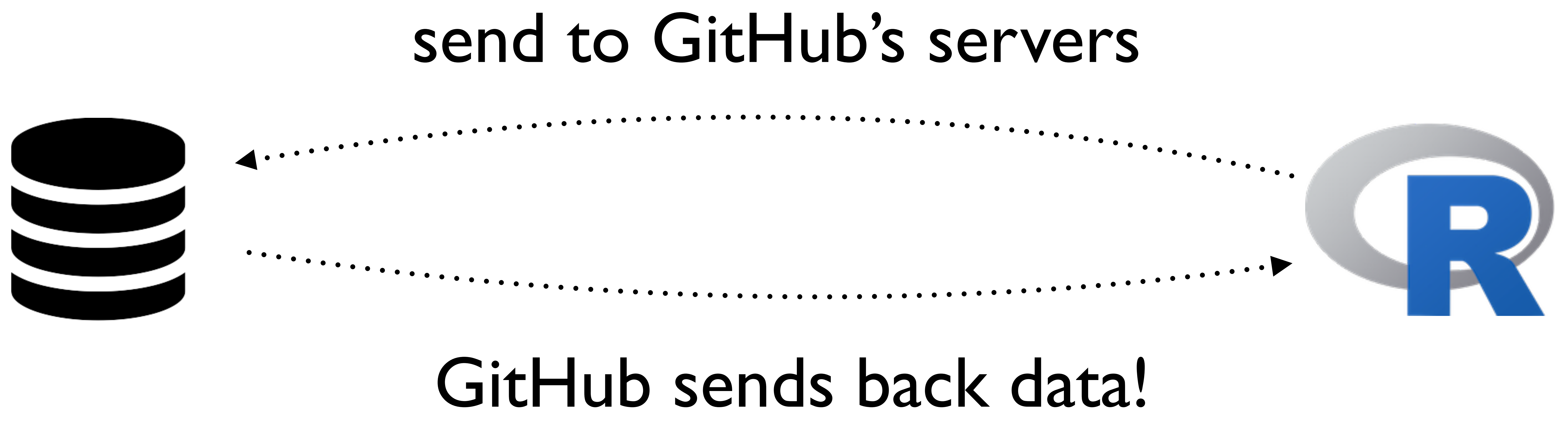
HTTP Verbs

GET	Retrieve whatever is specified by the URL
POST	Create resource at URL with given data
PUT	Update resource at URL with given data
DELETE	Delete resource at URL

HTTP Verbs: GET

GET https://api.github.com/repos/hadley/dplyr/issues?per_page=3





HTTP Verbs: POST

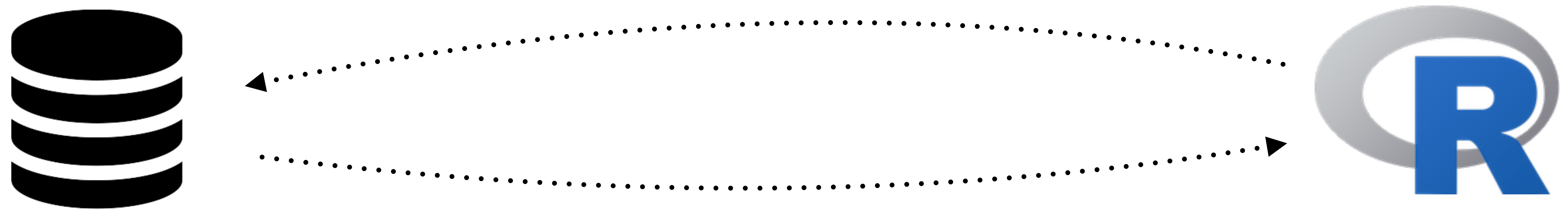
POST https://api.github.com/repos/hadley/dplyr/issues

base url

path

body

```
{
  "title": "Found a bug",
  "body": "I'm having a problem with this.",
  "assignee": "wch",
  "milestone": 2,
  "labels": [
    "bug"
  ]
}
```



HTTP Verbs: PUT

issue
#

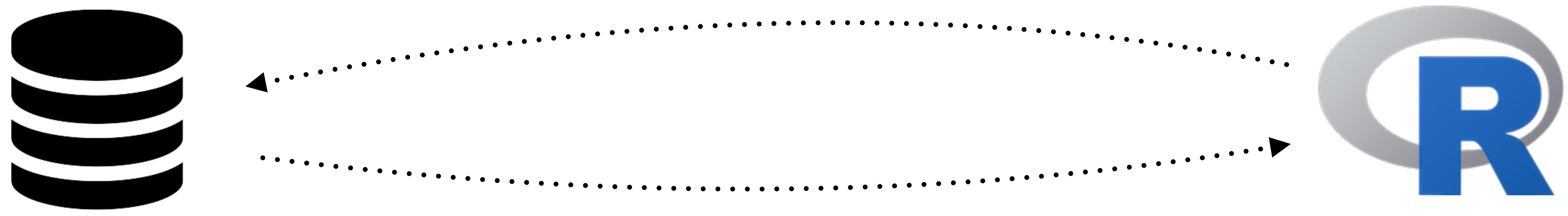
PUT https://api.github.com/repos/hadley/dplyr/issues/3

base url

path

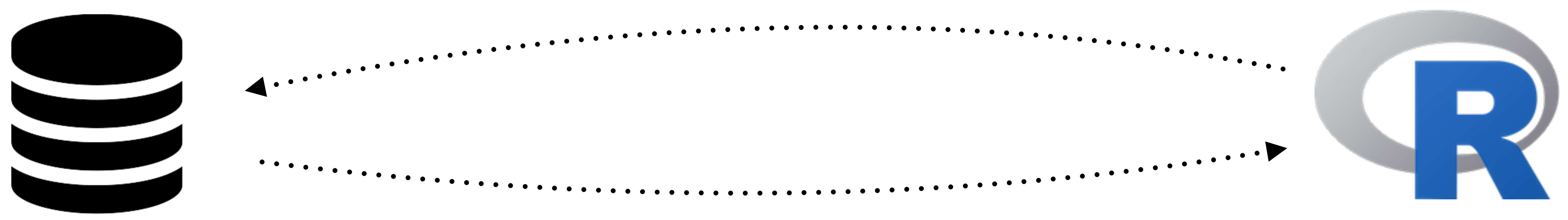
```
{
  "title": "Found a bug",
  "body": "I'm having a problem with this.",
  "assignee": "wch"
}
```

body



HTTP Verbs: DELETE

DELETE $\underbrace{\text{https://api.github.com}}_{\text{base url}}\underbrace{\text{/repos/sckott/foobar}}_{\text{path}}$



more HTTP Verbs

- HEAD - identical to GET, but just gets headers back
- PATCH - similar to PUT, but partially modify
- COPY - copy a resource from one URI to another
- OPTIONS - get what verbs supported for a URI
- a few others: TRACE, CONNECT

Assembling Queries

HTTP request components

- **URL** - where on the web do you want to make the request, including parameter values
- **Method** - what HTTP verb
- **Headers** - any metadata to modify the request
- **Body** - the data, very flexible, containing strings, files, binary, etc.

Assembling Queries: in R

URL

```
http://…
e.g., GET(url = “http://xxx”)
```

Headers

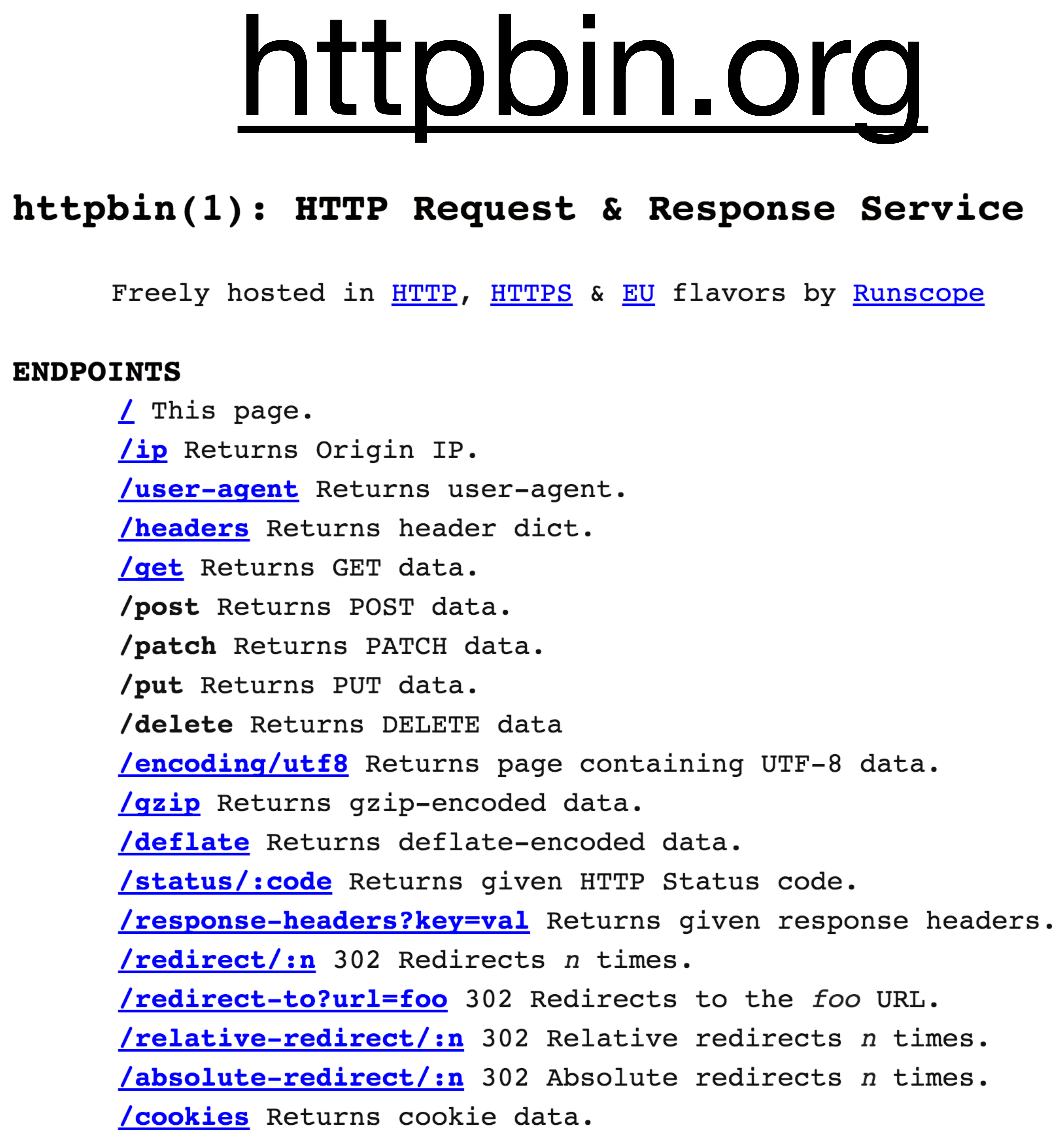
```
httr::add_headers(hello = “world”)
```

Method

```
httr::GET()
httr::POST()
httr::PUT()
httr::DELETE()
…
```

Body

```
httr::POST(body = list(foo = “bar”))
```



httpbin.org

httpbin(1): HTTP Request & Response Service

Freely hosted in HTTP, HTTPS & EU flavors by Runscope

ENDPOINTS

- **/** This page.
- **/ip** Returns Origin IP.
- **/user-agent** Returns user-agent.
- **/headers** Returns header dict.
- **/get** Returns GET data.
- **/post** Returns POST data.
- **/patch** Returns PATCH data.
- **/put** Returns PUT data.
- **/delete** Returns DELETE data
- **/encoding/utf8** Returns page containing UTF-8 data.
- **/gzip** Returns gzip-encoded data.
- **/deflate** Returns deflate-encoded data.
- **/status/:code** Returns given HTTP Status code.
- **/response-headers?key=val** Returns given response headers.
- **/redirect/:n** 302 Redirects *n* times.
- **/redirect-to?url=foo** 302 Redirects to the *foo* URL.
- **/relative-redirect/:n** 302 Relative redirects *n* times.
- **/absolute-redirect/:n** 302 Absolute redirects *n* times.
- **/cookies** Returns cookie data.

Your Turn

httr verbs practice

- **GET** request to https://httpbin.org/get
- **POST** request to https://httpbin.org/post
- Try mismatching a httr method with a httpbin URL, what happens?

Request Components

- Send a request with query parameters
- Send a request with a header
- Send a request with a body

04:00

```r
library(httr)

GET("https://httpbin.org/get")

POST("https://httpbin.org/post")

x <- POST("https://httpbin.org/get")
x$status_code
#>[1] 405
METHOD NOT ALLOWED!!!!
```

```r
library(httr)

# Request with query parameters
x <- GET(url, query = list(a = 5))

# Request with headers
x <- GET(url, add_headers(wave = "hi"))

# Request with a body
x <- POST(url, body = list(a = 5))
```

HTTP Responses

HTTP response components

- **status** - status of the response
- **headers** - response headers, like content type, size of body, paging info, rate limit info, etc.
- **body/content** - many different types, compressed or not, binary or not, etc.

status

- 3 digit numeric code
- One of 5 different classes of codes:
  - **1xx**: informational
  - **2xx**: success
  - **3xx**: redirection
  - **4xx**: client error
  - **5xx**: server error

- Info on status codes: https://en.wikipedia.org/wiki/List_of_HTTP_status_codes
- In R: https://cran.rstudio.com/web/packages/httpcode/ for HTTP status code look up

status: beware

- Servers do not always give correct codes

- Clients may pass on these inappropriate codes

- i.e., Don’t trust status codes alone - use in combination with other information:
  - content type
  - body length
  - etc.

Your Turn

Look up different status codes by using

https://http.cat/<HTTP STATUS CODE>

02:00

418: “I’m a teapot”

https://http.cat/418

headers

- Contain metadata about the **Request** & **Response**
- Some headers standardized
- Some headers custom for the web service
- Most headers **key:value** pairs
- Some headers just **value** without a key

headers

http://httpbin.org/get

request

```
GET /get HTTP/1.1
Accept: */*
Accept-Encoding: gzip, deflate
Connection: keep-alive
Host: httpbin.org
User-Agent: HTTPie/0.9.2
```

response

```
HTTP/1.1 200 OK
Access-Control-Allow-Credentials: true
Access-Control-Allow-Origin: *
Connection: keep-alive
Content-Length: 228
Content-Type: application/json
Date: Wed, 22 Jun 2016 16:12:04 GMT
Server: nginx
```

content / body

```
x <- GET('https://google.com/')
x$content
#>[1] 3c 21 64 6f 63 74 79 70 65 20 68 …

content(x)
```

raw bytes

to extract data

More in Part II

Your Turn

Using http://httpbin.org/get

- Get status code from an httr response object - Use httr to figure out what the code means

- From a http response: Get request & response headers -> Then extract content type

- Change the request content type - i.e,. the accept content type

Using http://httpbin.org/status/<status code>

- Do request for each of 400, and 500 - what do you get for content()?

05:00

```
library(httr)

res <- GET(“http://httpbin.org/get")

# status code
code <- res$status_code
http_status(code) # or http_status(res)

# content type
res$request$headers[[1]]
res$headers$`content-type`

# change accept content type
res <- GET(“http://httpbin.org/get”, accept_json())
```

```
library(httr)

# status code: 400
res <- GET(“http://httpbin.org/status/400”)
res
#> [1] NULL

# status code: 500
res <- GET(“http://httpbin.org/status/500”)
res
#> [1] NULL


# the content isn’t always empty!  Look in content AND
headers for error messages
```

Data Formats

JSON

http://www.omdbapi.com/?t=frozen&y=&plot=short&r=json

```
{
  "Title": "Frozen",
  "Year": "2013",
  "Rated": "PG",
  "Released": "27 Nov 2013",
  "Runtime": "102 min",
  "Genre": "Animation, Adventure, Comedy",
  "Director": "Chris Buck, Jennifer Lee",
  "Writer": "Jennifer Lee (screenplay), Hans Christian Andersen (story inspired by \"The Snow Queen\" by), 
Chris Buck (story by), Jennifer Lee (story by), Shane Morris (story by)",
  "Actors": "Kristen Bell, Idina Menzel, Jonathan Groff, Josh Gad",
  "Plot": "When the newly crowned Queen Elsa accidentally uses her power to turn things into ice to curse her 
home in infinite winter, her sister, Anna, teams up with a mountain man, his playful reindeer, and a snowman 
to change the weather condition.",
  "Language": "English, Icelandic",
  "Country": "USA",
  "Awards": "Won 2 Oscars. Another 70 wins & 56 nominations.",
  "Poster": "http://ia.media-imdb.com/images/M/
MV5BMTQ1MjQwMTE5OF5BMl5BanBnXkFtZTgwNjk3MTcyMDE@._V1_SX300.jpg",
  "Metascore": "74",
  "imdbRating": "7.6",
  "imdbVotes": "410,734",
  "imdbID": "tt2294629",
  "Type": "movie",
  "Response": "True"
}
```

JSON

- **J**avascript **O**bject **N**otation

- Widely used in web APIs
- Becoming de facto standard for data format for web APIs
- less expressive than XML
- but easier for humans to grok
- jsonlite - the go to JSON pkg for R, to create and parse JSON

jsonlite

https://cran.rstudio.com/web/packages/jsonlite

```
library(jsonlite)
fromJSON('{"foo": "bar"}')
#> $foo
#> [1] "bar"

fromJSON('{"foo": "bar"}', FALSE)
#> $foo
#> [1] "bar"

fromJSON('[{"foo": "bar", "hello": "world"}]')
#>   foo hello
#> 1 bar world
```

XML

http://www.omdbapi.com/?t=frozen&y=&plot=short&r=xml

```
<root response="True">
    <movie title="Frozen" year="2013" rated="PG" released="27 Nov
   2013" runtime="102 min" genre="Animation, Adventure, Comedy"
   director="Chris Buck, Jennifer Lee" writer="Jennifer Lee
   (screenplay), Hans Christian Andersen (story inspired by
   &quot;The Snow Queen&quot; by), Chris Buck (story by), Jennifer
   Lee (story by), Shane Morris (story by)" actors="Kristen Bell,
   Idina Menzel, Jonathan Groff, Josh Gad" plot="When the newly
   crowned Queen Elsa accidentally uses her power to turn things
   into ice to curse her home in infinite winter, her sister,
   Anna, teams up with a mountain man, his playful reindeer, and a
   snowman to change the weather condition." language="English,
   Icelandic" country="USA" awards="Won 2 Oscars. Another 70 wins
   & 56 nominations." poster="http://ia.media-imdb.com/images/M/
   MV5BMTQ1MjQwMTE5OF5BMl5BanBnXkFtZTgwNjk3MTcyMDE@._V1_SX300.jpg"
   metascore="74" imdbRating="7.6" imdbVotes="410,734"
   imdbID="tt2294629" type="movie"/>
</root>
```

XML

- E**x**tensible **M**arkup **L**anguage

- Used to dominate in web APIs, no less common
- Very expressive
- hard for humans to grok
- xml2 - the go to XML pkg for R, to create and parse XML

xml2

https://cran.rstudio.com/web/packages/xml2

```
library(xml2)


res <- read_xml('<foo>bar</foo>')
xml_name(res)
#> [1] “foo"


xml_text(res)
#> [1] "bar"
```

Your Turn

Using the IMDB API: http://www.omdbapi.com/

Get data for 3 movies in both JSON and XML format.

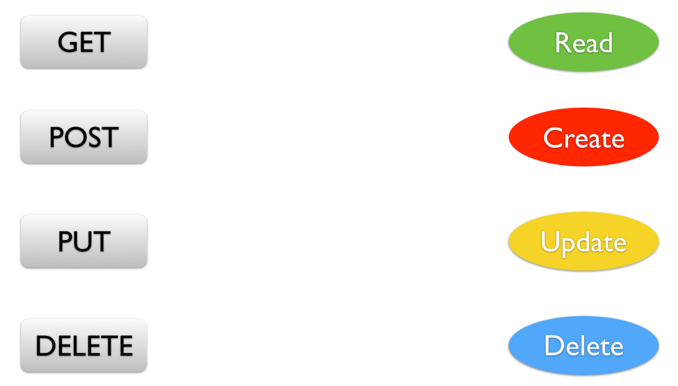
Parse each format to plain text and their parsed versions.

04:00

```
library(httr)

j1 = GET(“http://www.omdbapi.com/?t=iron%20man%202&r=json”)

content(j1, as = “text”)
content(j1, as = “parsed”)



x1 = GET(“http://www.omdbapi.com/?t=iron%20man%202&r=xml")

content(x1, as = “text”)
content(x1, as = “parsed”)
```

Recap

APIs: many components - we focused on HTTP



HTTP verbs: **GET ➔ POST ➔ PUT**, **DELETE,** etc.

URL / Methods / Header / Body

HTTP **request**

Status / Headers / Body

HTTP **response**

{"foo": "bar"}
<foo>bar</foo>

Data formats: **JSON** and **XML**

thank you