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2. APIs, Dictionaries, and JSON

What definitions do you know?

- API
- SDK
- Library
- Framework
- REST
- SOAP

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Definitions

- Application Programming Interface (API) - set of rules structuring interaction between applications
- Library - set of related, reusable code (e.g. pandas, matplotlib)
- Framework - structured code that makes it easier for a programmer or developer to create an desktop/mobile/web application; it usually includes a set of libraries to perform various tasks
- REST - most popular type of API; an architectural style
- SOAP - more secure version of REST
- Software Development Kit (SDK) - set of tools which can include libraries, APIs, frameworks, etc.

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Announcements

- Tomorrow (June 18) is a holiday - there will be no sessions!
- If you will be absent, please notify your TA AND Heaven (feel free to Slack them)

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What you will be able to do:

- Define Differences between libraries, SDKs, APIs, and frameworks
- Describe how an API works using the correct terminology
- Implement a GET request that retrieves JSON data from an API
- Explain how hashing works
- Perform basic operations on Dictionaries
- Parse JSON to generate interesting output

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Tools you will need for today:

- extra screen (your phone works!)
- pencil and scratch paper (8.5” x 11” ish)

  … or screen and stylus

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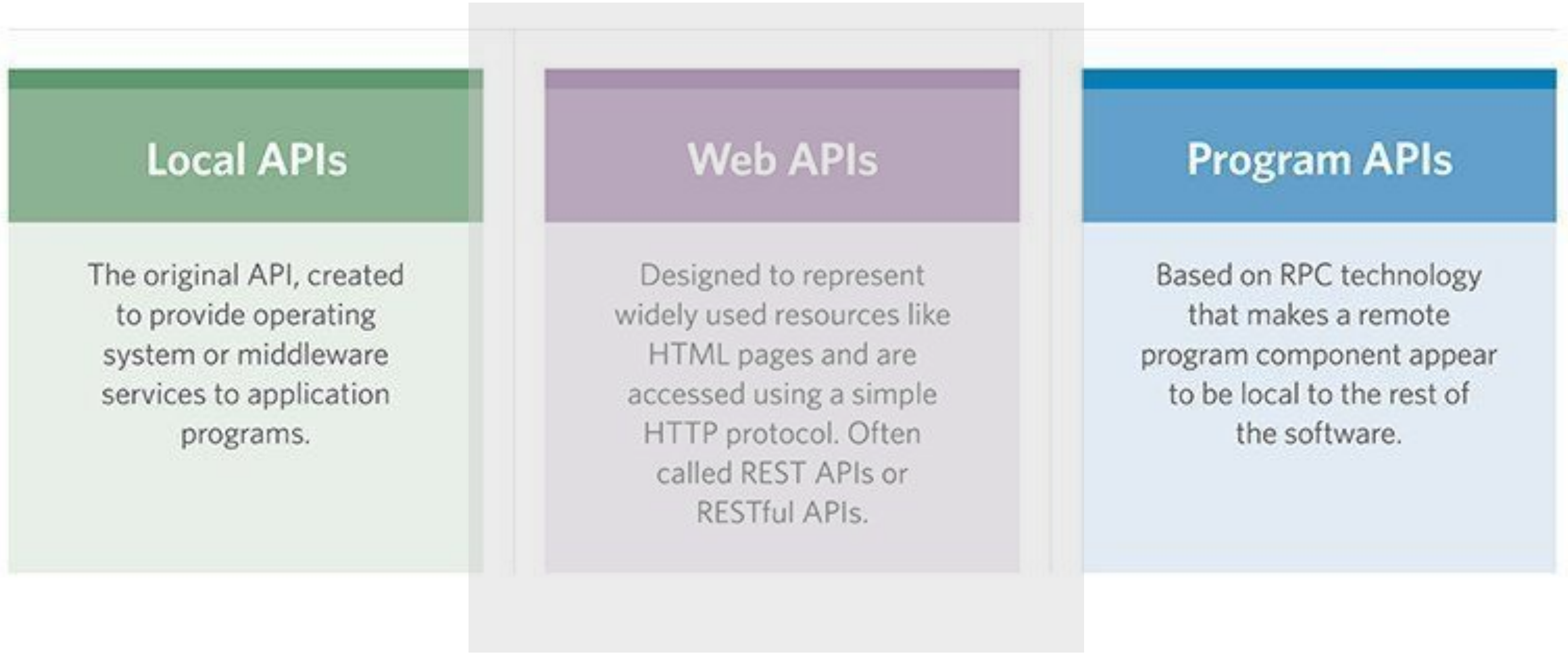
APIs

Types of APIs



Local APIs

The original API, created to provide operating system or middleware services to application programs.

Web APIs

Designed to represent widely used resources like HTML pages and are accessed using a simple HTTP protocol. Often called REST APIs or RESTful APIs.

Program APIs

Based on RPC technology that makes a remote program component appear to be local to the rest of the software.

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Why Use APIs?

A popular goal for using many (web) APIs is to get information!

- Want to build a music web app that displays lyrics to a song? The Genius.com API provides lyrics to a bunch of songs!
- Want to build a web app that displays the weather from any location you input? The weather.com API provides forecasts!
- Want to build a web app that displays recipes using specific ingredients? the Spoonacular.com API provides recipes!

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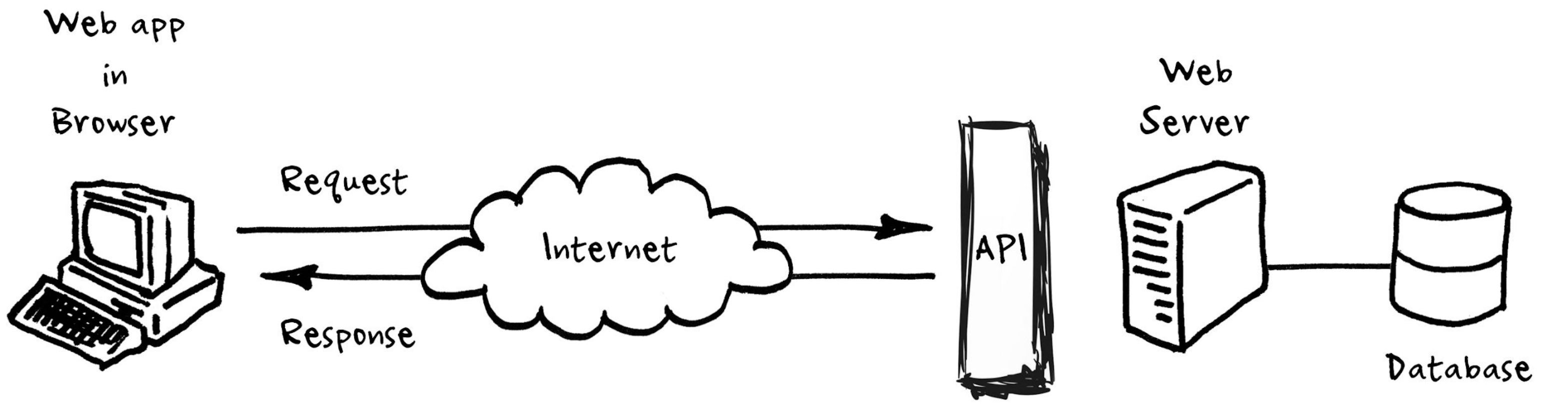
How APIs work

To access and interface with a site's stored information, we need to use their provided APIs:

1. Client sends a request for resources using an API endpoint , which includes a URL and parameters
2. Server sends response with the resource



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Let’s draw this out.

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API Diagram

Say I want to create a web app that pulls in random lyrics of my favorite artist. Instead of manually typing up 100m + songs, I can use lyrics from genius.com....

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HTTP Requests

	HTTP Method	Path	Protocol Version
Start Line	GET	/codio/home	http/1.1
HTTP Headers	mandatory	Host: codio.com	
	optional	Accept-Language: en	
Empty String			
Message Body *(optional)*			

- Request methods:
  - GET – requests resource
  - POST – requests resource be posted on server (e.g. posting on a forum)
  - PUT – requests resource be put in specific place on server
  - DELETE – request resource is removed from server

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Making HTTP Requests (the easy way)

- HTTP requests are generally formulated on our behalf via…
  - software (such as a browser)
  - a library such as the requests library python
  - a shell command, such as curl.
- When requesting information, all we usually have to do is usually provide the HTTP method (GET in our case)* and the host to send the request to.

* *In some cases, you don't even need to provide GET!*

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HTTP Responses

	Protocol Version	Status Code	Status Message
Start Line	**http/1.1**	**200**	**OK**
HTTP Headers	content-length=[1256]		
	content-type=[text/html; charset=UTF-8]		
	date=[Thu, 02 Mar 2023 20:25:34 GMT]		
Empty String			
Message Body *(optional)*	<!doctype html>		
	<html>		
	<head>		
	<title>Example Domain</title>		

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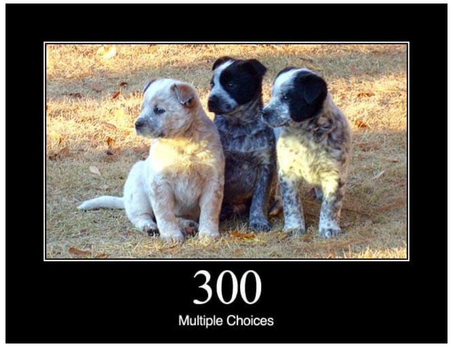
HTTP Response Status Code Classes

- The first digit of the status code indicates it's class:
  - 1XX (informational) - the request was received, continuing process
  - 2XX (successful) - request received, understood, and accepted
  - 3XX (redirection) - further action needed to complete the request
  - 4XX (client error) - the request cannot be fulfilled (bad syntax)
  - 5XX (server error) - the server failed to fulfill a valid request



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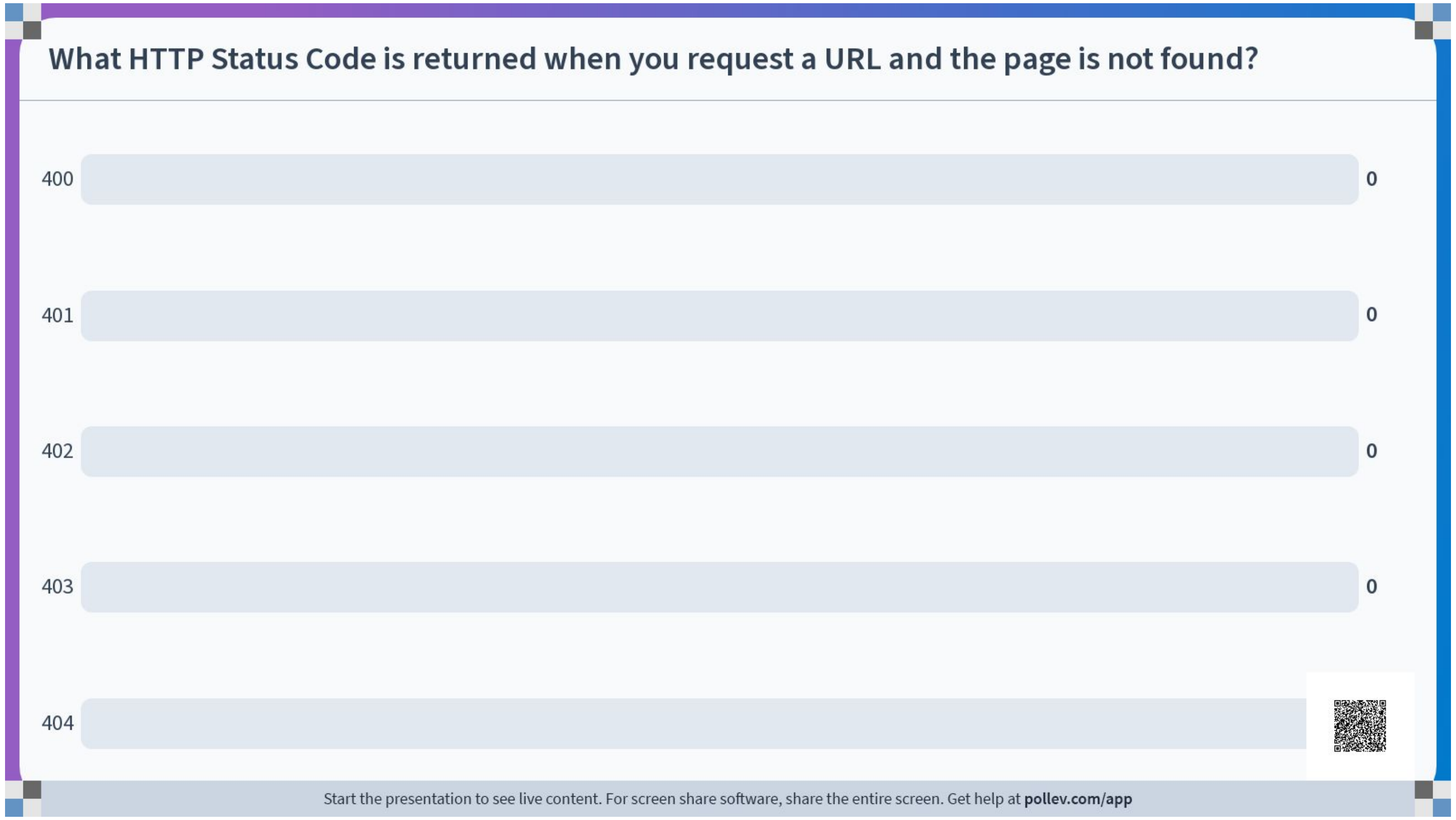

What HTTP Status Code is returned when you request a URL and the page is not found?

400	0
401	0
402	0
403	0
404	

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404 - One of the most popular HTTP statuses

404

Sorry , the page not found

The link you followed probably broken
or the page has been removed.

404

page not found

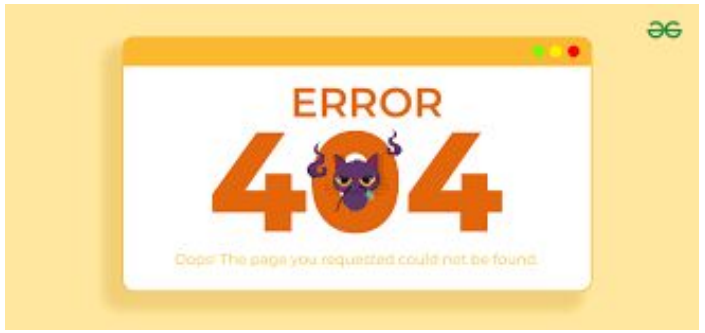
404

PAGE NOT BE FOUND

404

We couldn't find the page you're looking for

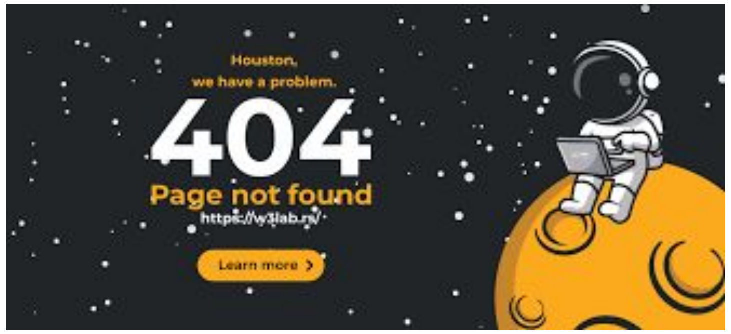
Try one of these



ERROR

404

Oops! The page you requested could not be found.

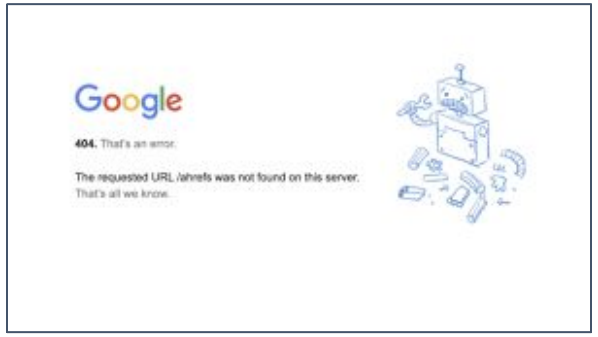


Houston,
we have a problem.

404

Page not found

https://w3lab.rs/



404. That's an error.

The requested URL /ahrefs was not found on this server.
That's all we know.

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Using an API - Making a Request

1. Head to the website's API documentation
2. Sign up/Register your app if needed
3. Find the data you want to access
4. Look for the endpoint needed to access the data
   - the endpoint is usually a URL when dealing with APIs
5. Use their endpoint and make an HTTP Request (from a service that does it for you)

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DEMO Using APIs

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Other Important API Considerations

- **Authentication** - sometimes needed to get access to data behind an API
  - There are a few popular methods:
    - Tokens
    - API keys
    - Oauth
  - Sometimes the authentication method you use determines what you have access to
  - Failed authentication will result in a 401 status

- Rate limits
  - APIs limit the rate of requests a client can send
  - When you exceed the limit, you get a 429 status

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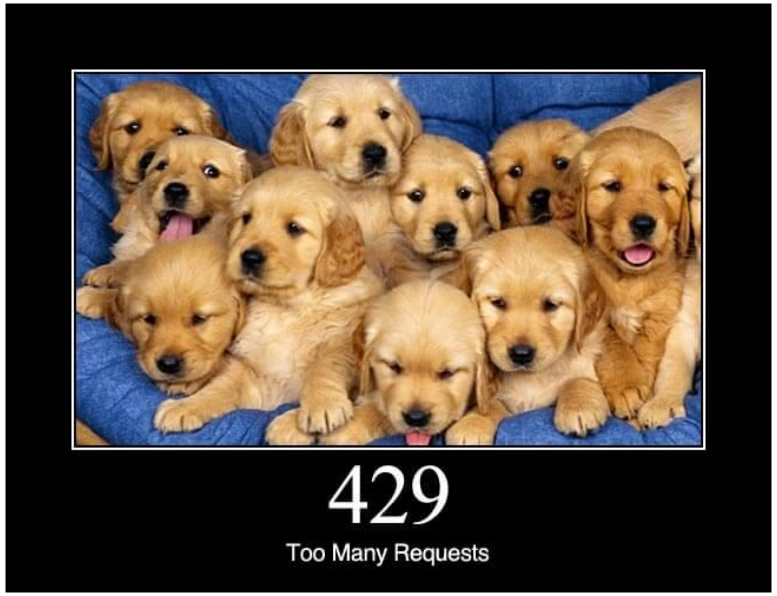

Read API Docs

- https://developer.spotify.com/documentation/web-api
    - What authentication methods can we use?
    - What time frame is used to monitor the rate limit?
    - What piece of information can you receive from the Spotify API, what endpoint do you use?

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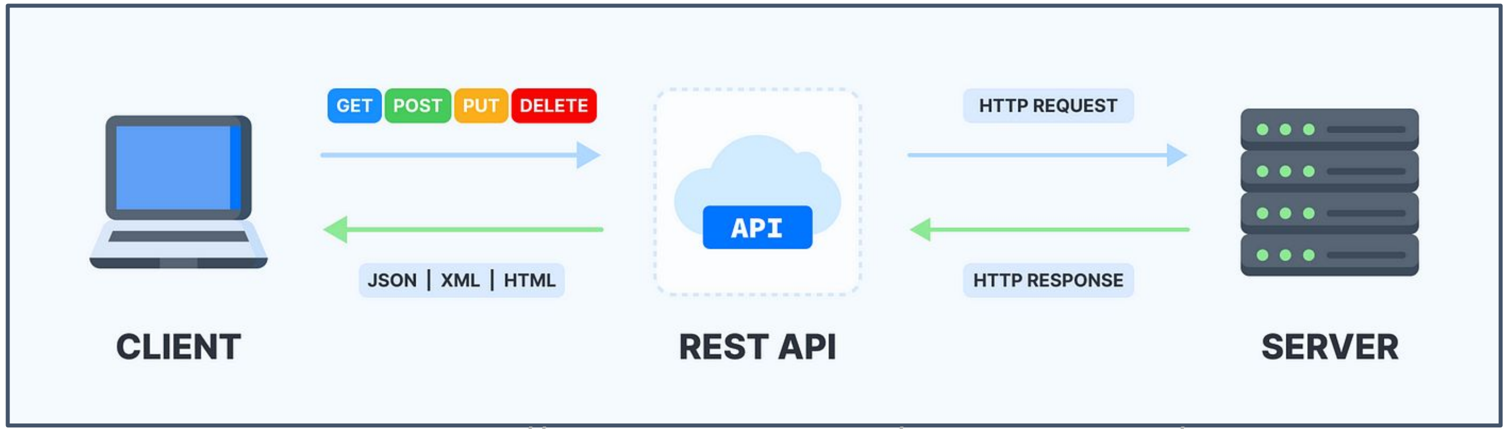
REST APIs

- Rest stands for REpresentational State Transfer
- It is an architecture style that was created to manage communication across complex networks (like the Internet)



source: https://medium.com/@MiMuuu/

- If a system is REST compliant (AKA adhere's to REST design principles) it is called RESTful

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REST Design Principles

1. **Uniform interface** - All API requests for the same resource should look the same
2. **Client-server decoupling** - client and server applications must be completely independent of each other
3. **Statelessness** - each request needs to include all the information necessary for processing it
4. **Cacheability** – Resource should be cacheable on the client or server side
5. **Layered system architecture** - calls and responses go through different layers.
6. **Code on demand (optional)** - REST APIs *usually* send static resources

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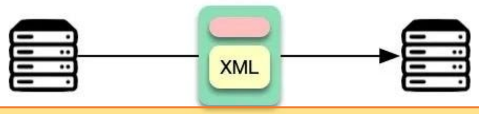
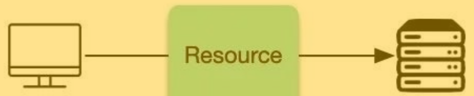
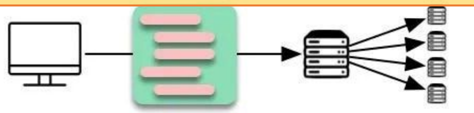
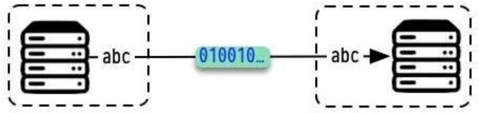
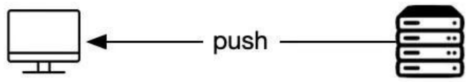
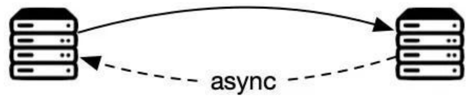
Types of API Architectures

Style	Illustration	Use Cases
SOAP		XML-based for enterprise applications
RESTful		Resource-based for web servers
GraphQL		Query language reduce network load
gRPC		High performance for microservices
WebSocket		Bi-directional for low-latency data exchange
Webhook		Asynchronous for event-driven application

source: www.bytebytego.com

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Dictionaries

Do you know the following definitions?

- Hashtable
- Hashing function
- Dictionary
- Key-Value Pair

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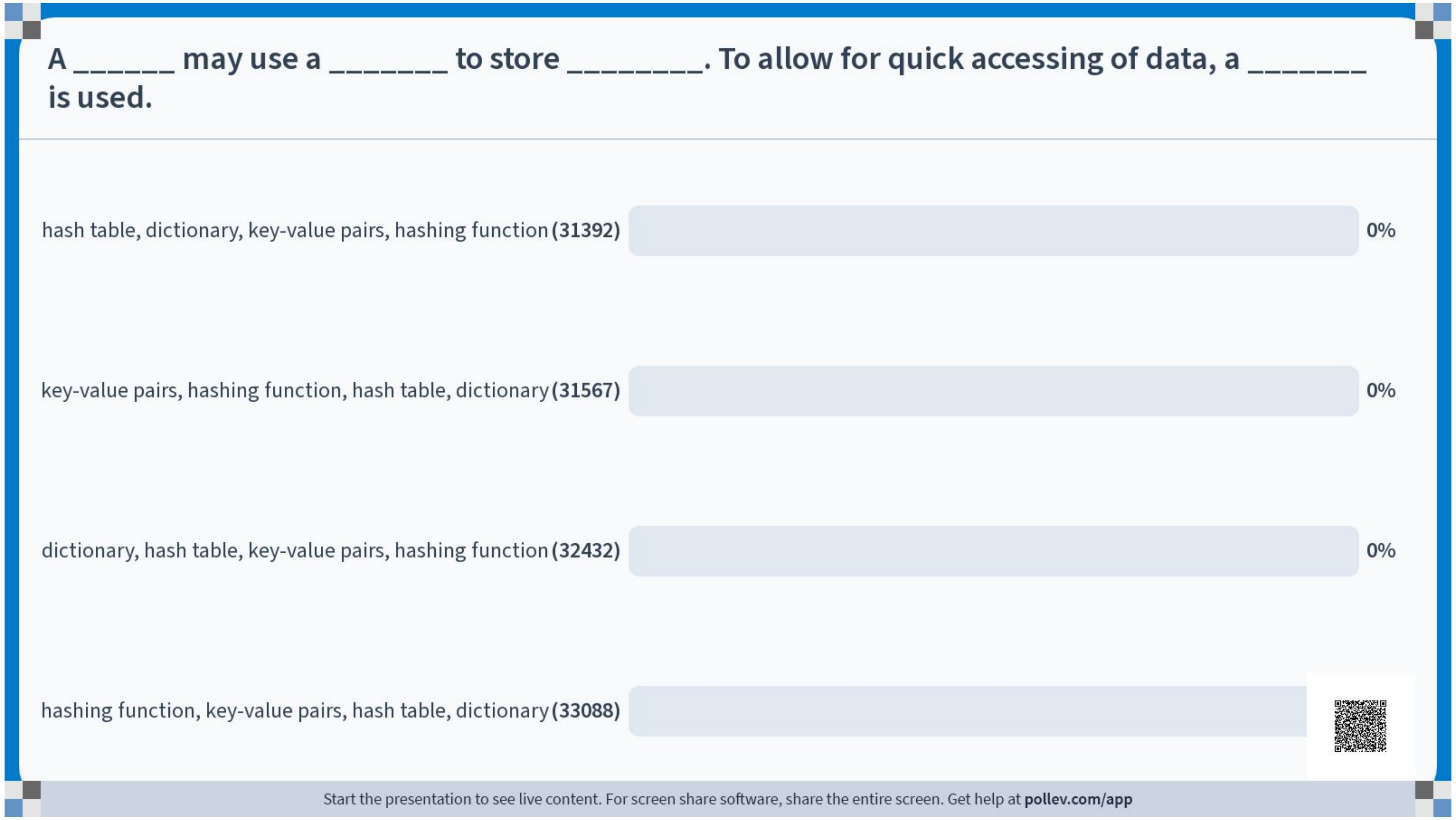

A ______ may use a _______ to store ________. To allow for quick accessing of data, a _______ is used.

hash table, dictionary, key-value pairs, hashing function **(31392)**	0%
key-value pairs, hashing function, hash table, dictionary **(31567)**	0%
dictionary, hash table, key-value pairs, hashing function **(32432)**	0%
hashing function, key-value pairs, hash table, dictionary **(33088)**	

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Definitions

Hash table – a data structure used to implement a dictionary as a means to allow quick look up keys to corresponding values

Hashing function – a one-way function often used to transform data into a random, formatted value. It can be used for encryption or indexing hashmaps or hash tables

Dictionary – the concept of storing data using a key and value system

Key-Value Pair – a hash table entry

- Fun fact, C# has Hashtables and Dictionaries as data structures - so take many of these definitions as high level

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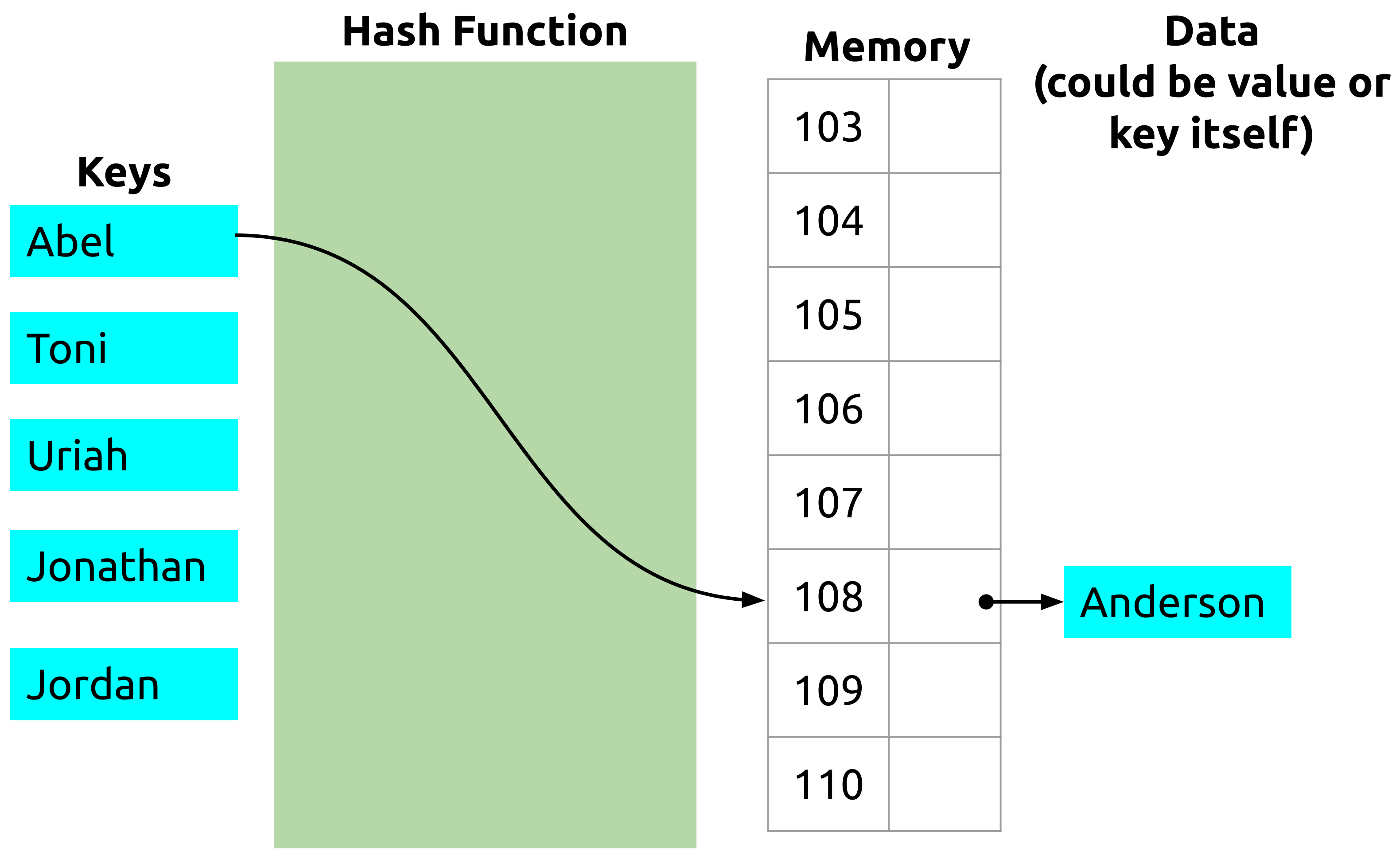
Hashing for Hashmaps and Tables....



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Python: Using Dictionaries

- Say you want to map your zipcode (key) to a city using the syntax #####: ‘city name’,
  - example:
    77478: ‘Sugar Land’,

- A way to create a list of key-value pairs in Python is:

```
zip_codes = { 11201: 'Brooklyn',
             94112: 'San Francisco' }
```

- Accessing information in dictionary:

```
  print(zip_codes[11201])
```

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Python: Modifying a Dictionary

`dictionary['key'] = new_value`
- creates/update a value:

`pop(key)`
– removes specified key and returns associated value

`popitem()`
– removes last item and returns tuple

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JSON

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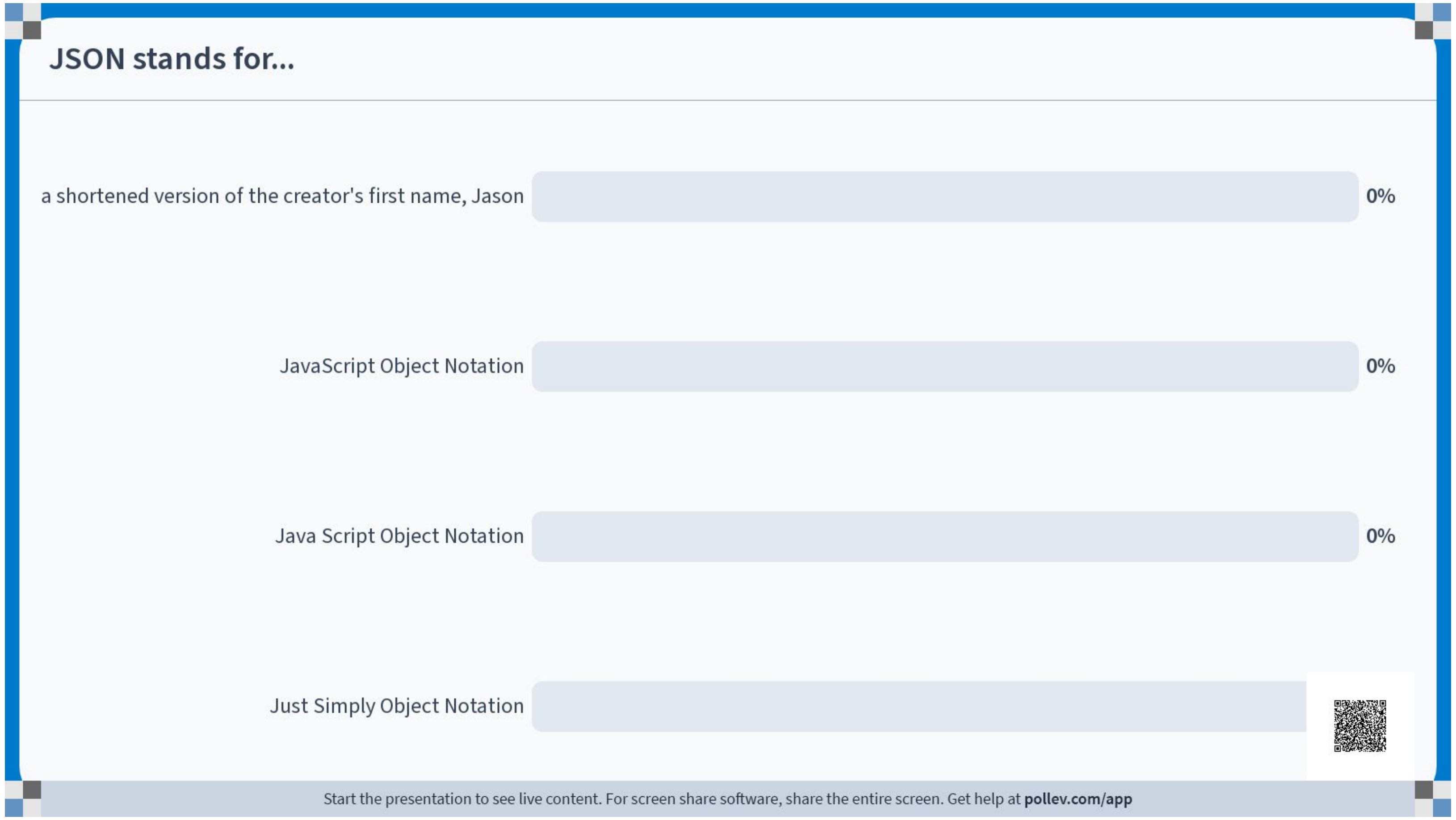

JSON stands for...

a shortened version of the creator's first name, Jason		0%
JavaScript Object Notation		0%
Java Script Object Notation		0%
Just Simply Object Notation		

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JavaScript Object Notation (JSON)

- Looks (and acts) like a dictionary with nested key-value pairs and lists
- Is sometimes returned as an API GET response
- Is easily parse-able by machines and systems
    - Python has `json` library with includes a function called `json.loads` that turns JSON into a dictionary data structure for easy manipulation!

```
{
    "firstName": "John",
    "lastName": "Smith",
    "age": 21,
    "address": {
        "streetAddress": "21 2nd Street",
        "city": "New York",
        "state": "NY",
        "zipCode": "10021"
    },
    "children": [
        "Mary",
        "James"
    ]
}
```

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JSON-ifying in Python

```python
import requests
import json

url = "https://api.genius.com/search?q=Kendrick%20Lamar"

my_headers = { "Authorization": "Bearer ACCESS_TOKEN" }

response = requests.get(url, headers=my_headers)
response_dict = json.loads(response.text);

print(response_dict["meta"]["status"]) // prints 200
```

```
codio@brazilindigo-gurusantana:~/workspace$
{"meta":{"status":200},"response":{"hits":[{"highl
ights":[],"index":"song","type":"song","result":{"
annotation_count":20,"api_path":"/songs/3039923","
artist_names":"Kendrick
Lamar","full_title":"HUMBLE. by Kendrick
Lamar","header_image_thumbnail_url":"https://image
s.genius.com/483306c535608c27f9e3781b854dc91d.300x
300x1.png","header_image_url":"https://images.geni
us.com/483306c535608c27f9e3781b854dc91d.1000x1000x
1.png","id":3039923,"lyrics_owner_id":104344,"lyri
cs_state":"complete","path":"/Kendrick-lamar-humbl
e-lyrics","pyongs_count":1203,"relationships_index
_url":"https://genius.com/Kendrick-lamar-humble-sa
mple","release_date_components":{"year":2017,"mont
h":3,"day":30},"release_date_for_display":"March
30....
```

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JSON Syntax, the basics

- Maps are denoted with `{}` (technically, these are called objects)
  - `{"a": 1, "b": 2, "c": 3}` is a map for a to 1, b to 2, and c to 3
  - JSON *always* starts with a '{' and ends with an '}'
- A few basic data types: numbers, strings, booleans, and nulls
- These types work as you would expect in any programming language
- Arrays using []
- [1, 2, 3, 4, 5] is an array of 1, 2, 3, 4, and 5

```
{
    "firstName": "John",
    "lastName": "Smith",
    "age": 21,
    "address": {
        "streetAddress": "21 2nd Street",
        "city": "New York",
        "state": "NY",
        "zipCode": "10021"
    },
    "children": [
        "Mary",
        "James"
    ]
}
```

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JSON Syntax, nesting

- Nested arrays and maps can live recursively inside each other, and vice versa
- `[{"name": "a"}, {"name": "b"}, {"name": "c"}]`
  is an array of maps, each one with a key called name
- `{"users": [{"name": "a"}, {"name": "b"}, {"name": "c"}]}`
  is a map with one key called users, whose value is an array of maps (described above)

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Reminders

- Check your Google Calendars for this week’s events!

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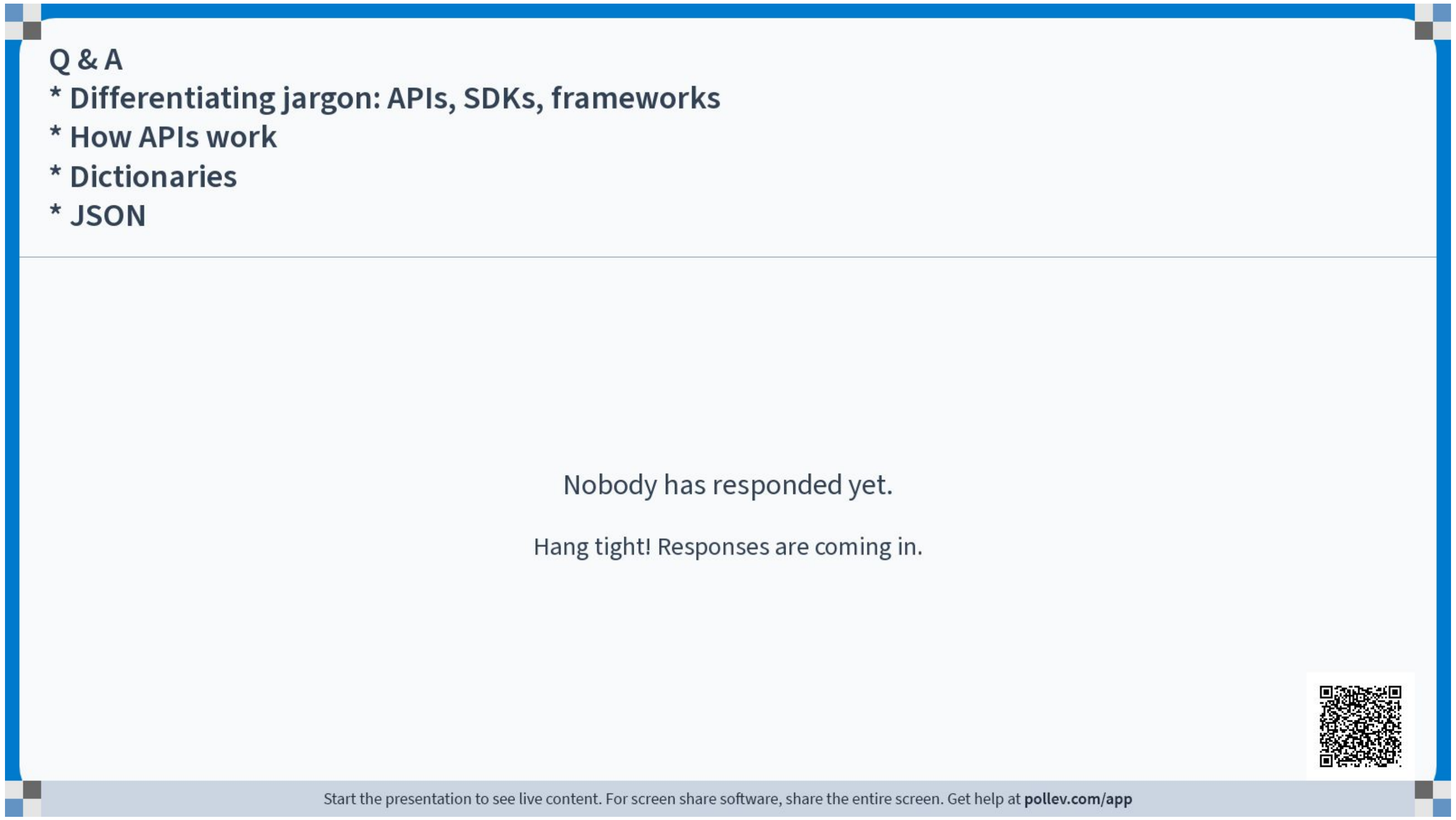

Q & A
* Differentiating jargon: APIs, SDKs, frameworks
* How APIs work
* Dictionaries
* JSON

Nobody has responded yet.

Hang tight! Responses are coming in.

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Thank you!