# Data Collection for Machine Learning

Week 1 · CS 203: Software Tools and Techniques for AI

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# Part 1: The Motivation

Why do we need to collect data?

# Imagine: You Work at Netflix

> **NETFLIX** — Your Boss: *"We have $500M budget for movie acquisitions. Which movies should we license?"*
>
> **The Question**: Can we predict which movies will succeed?

**Your Role**: Data Scientist

**Your Mission**: Build a model to predict movie success

# The Problem Statement

**Goal**: Predict box office revenue based on movie attributes


**But wait...** What features? What data? Where does it come from?

# What We Need: The Target Dataset

| Title | Year | Genre | Budget | Revenue | Rating | Director | Cast |
|---|---|---|---|---|---|---|---|
| Inception | 2010 | Sci-Fi | $160M | $836M | 8.8 | C. Nolan | DiCaprio |
| Avatar | 2009 | Action | $237M | $2.9B | 7.9 | Cameron | Worthington |
| The Room | 2003 | Drama | $6M | $1.9M | 3.9 | Wiseau | Wiseau |
| ... | ... | ... | ... | ... | ... | ... | ... |

**We need 10,000+ movies** with complete information.

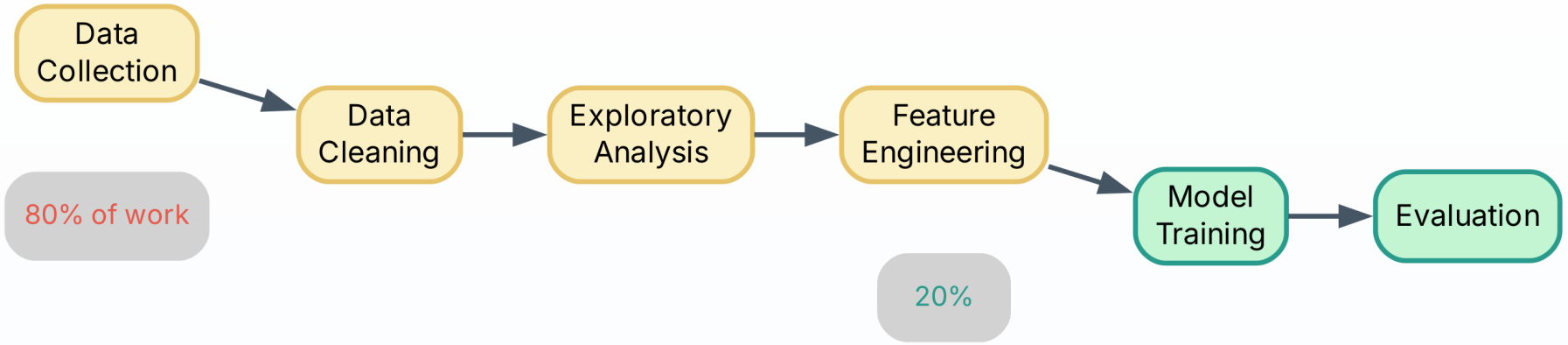
**Question**: Where does this data come from?

# The Reality Check

- This data doesn't exist in one place
- No single CSV file with everything
- Can't just "download" the dataset
- **We must BUILD the dataset ourselves**

**This is the real world of data science.**

# The ML Pipeline Reality




**The uncomfortable truth**:

- 80% of ML work is data engineering
- Models are the easy part
- **Garbage In = Garbage Out**

# Why Is Data Collection So Hard?

> **The Data Collection Paradox**: The data you need rarely exists in the form you need it.

## Real challenges you'll face:

| Challenge | Example |
|---|---|
| **Scattered sources** | Movie info on IMDb, revenue on Box Office Mojo, reviews on Rotten Tomatoes |
| **Different formats** | JSON from APIs, HTML from websites, CSV from downloads |
| **Missing values** | Budget data missing for 40% of movies |
| **Inconsistent naming** | "The Dark Knight" vs "Dark Knight, The" vs "Batman: The Dark Knight" |
| **Rate limits** | API allows only 100 requests/day |

# Today's Mission

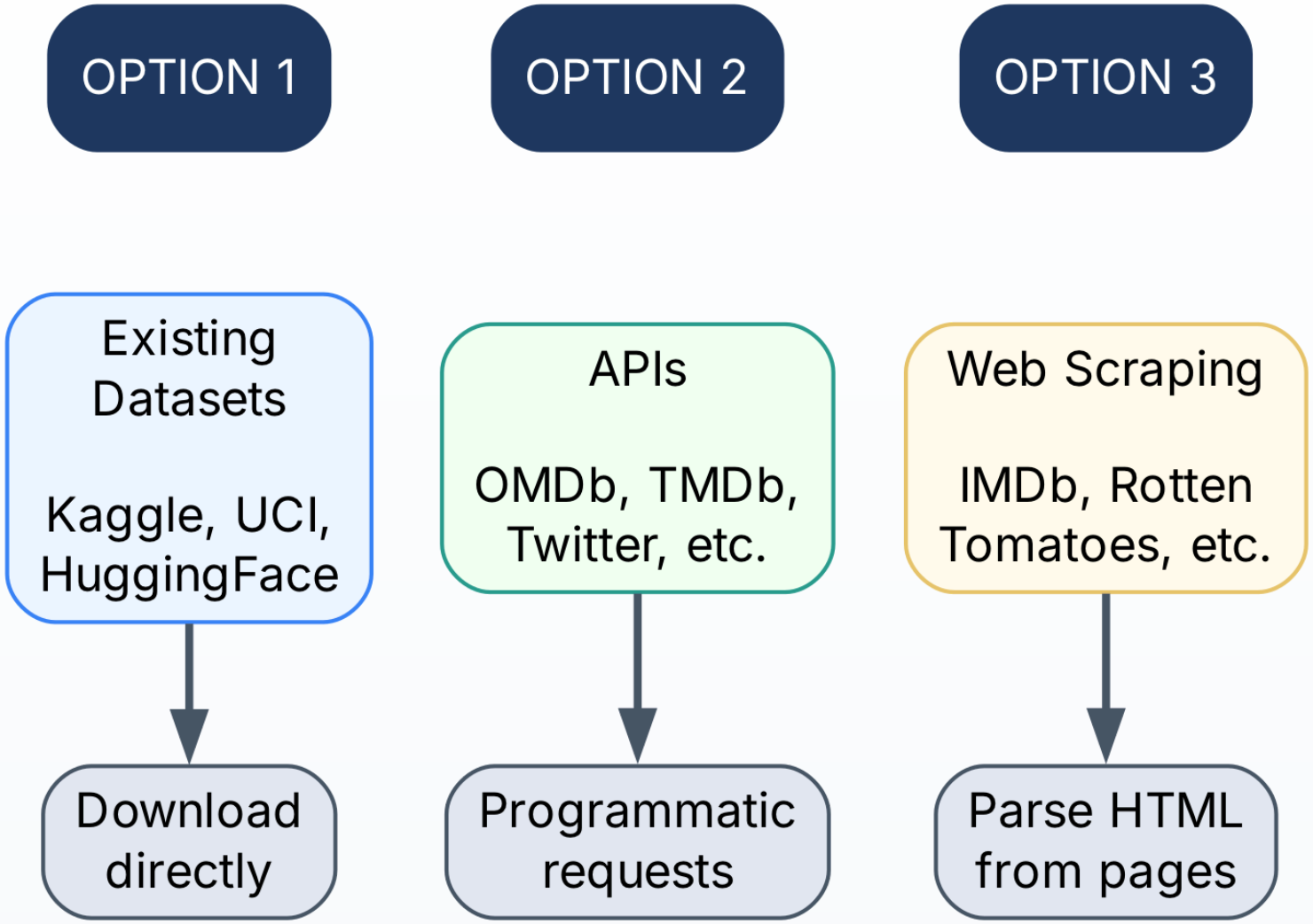
**By the end of this lecture, you will know how to:**

1. Find data sources for any project
2. Understand how the web works (HTTP)
3. Use Chrome DevTools to inspect network traffic
4. Make requests using curl from the command line
5. Write Python scripts with the requests library
6. Handle different data formats
7. Scrape websites when APIs don't exist

# Part 2: Where Does Data Come From?

*Finding the right sources*

# Three Ways to Get Data



# Option 1: Pre-built Datasets

**Where to find them:**

| Source | Example Datasets | Pros | Cons |
|---|---|---|---|
| Kaggle | Movies, Titanic, Housing | Ready to use, competitions | May be outdated |
| UCI ML Repository | Classic ML datasets | Well-documented | Academic focus |
| HuggingFace | NLP datasets, models | Easy loading | Specialized |
| Government Portals | Census, economic data | Authoritative | Limited scope |

**Verdict**: Great starting point, but often not enough for real projects.

# Option 2: APIs (Application Programming Interface)

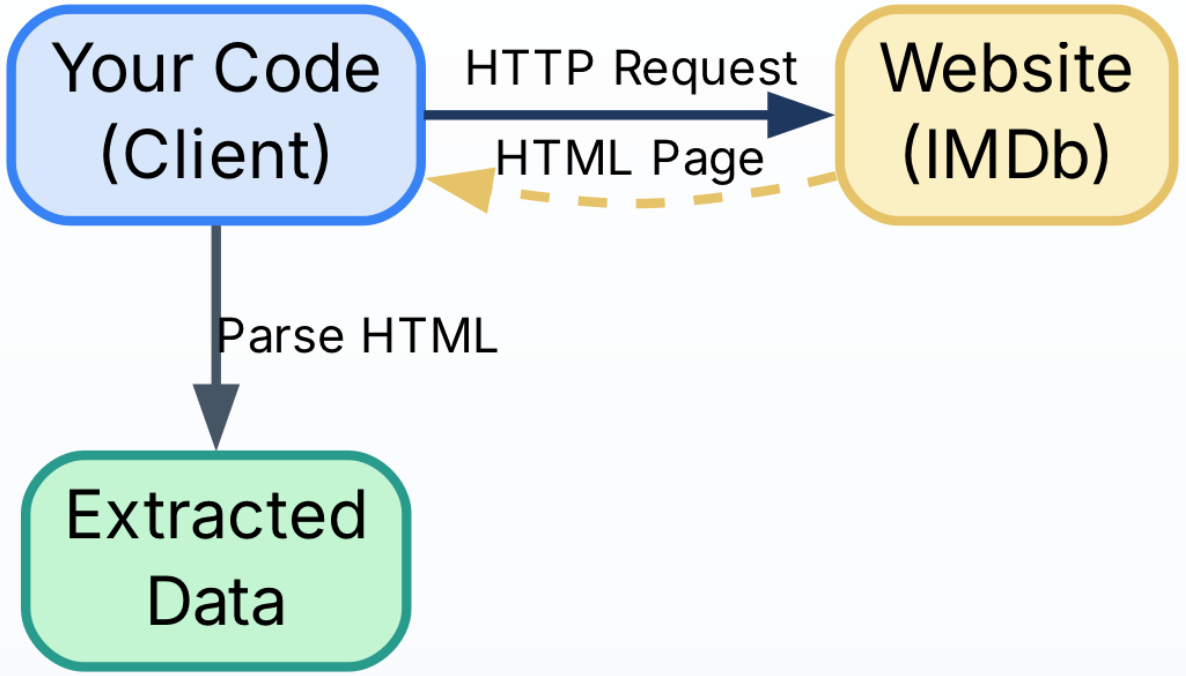

**APIs** = Structured way to request data from servers

**Examples for our Netflix project:**

- **OMDb API**: Movie metadata (title, year, ratings)
- **TMDb API**: Detailed movie info, cast, crew
- **Box Office Mojo**: Revenue data

# Option 3: Web Scraping

When APIs don't exist or don't have what you need:




**When to scrape**: Reviews, prices, content not in APIs.

# Our Strategy for Netflix Project

| Data Needed | Source | Method |
|---|---|---|
| Movie titles, years | OMDb API | API calls |
| Ratings, genres | OMDb API | API calls |
| Budget, revenue | TMDb API | API calls |
| User reviews | IMDb website | Scraping |
| Critic reviews | Rotten Tomatoes | Scraping |

**Today's focus**: Learn both API calls and scraping.

# Decision Tree: How to Get Data

**Ask these questions in order:**

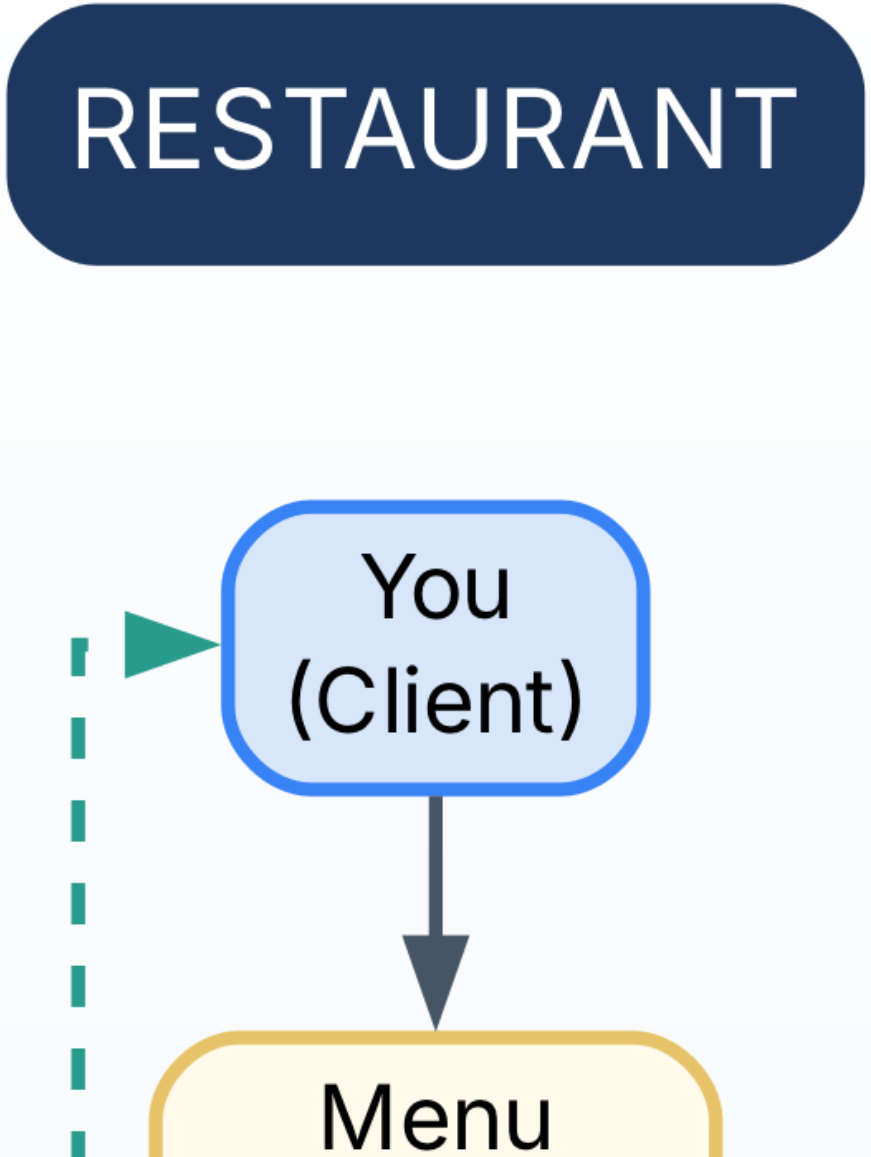
```
1. Does a ready-made dataset exist?
   → YES: Download it (Kaggle, HuggingFace)
   → NO: Continue...

2. Does an official API exist?
   → YES: Is it free/affordable? Has the data you need?
     → YES: Use the API
     → NO: Continue...

3. Can you scrape the website?
   → Check robots.txt and ToS
   → YES: Scrape ethically
   → NO: Look for alternative sources or contact the company

4. None of the above?
```

**Most real projects use a combination of all methods!**

# Part 3: What is an API?

*The contract between programs*

# API: A Restaurant Analogy



# API: The Formal Definition

## API (Application Programming Interface)

A defined set of rules and protocols for building and interacting with software applications.

```
# Without API (direct database access - dangerous!)
SELECT * FROM movies WHERE title = 'Inception';

# With API (safe, controlled access)
GET /movies?title=Inception
```

**APIs provide**:

- Security (no direct DB access)
- Rate limiting (fair usage)
- Versioning (backwards compatibility)
- Documentation (how to use it)

# Why Do APIs Exist?

> **Think of it this way**: APIs are like a bank teller window. You can't walk into the vault yourself, but you can request specific transactions through a controlled interface.

**Without APIs** (direct database access):

- Anyone could read ALL your data
- Anyone could modify or delete data
- No way to track who's doing what
- Server could be overwhelmed

**With APIs** (controlled access):

- Only expose what you want to share
- Validate every request
- Log and monitor usage

# Reading API Documentation

> **Before making any API call, always check the documentation for:**

1. **Base URL** - Where do requests go? (e.g., `https://api.omdbapi.com`)
2. **Authentication** - API key? OAuth token? Where does it go?
3. **Endpoints** - What resources are available? (`/movies`, `/search`)
4. **Parameters** - What can you filter/search by?
5. **Rate limits** - How many requests per minute/day?
6. **Response format** - What fields come back? What types?

**Example from OMDb API docs:**

```
Base URL: https://www.omdbapi.com/
Auth: apikey parameter in URL
Endpoints: / (single endpoint, parameters control behavior)
```

# Types of APIs

| Type | Description | Example |
| --- | --- | --- |
| REST API | HTTP-based, stateless, resource-oriented | OMDb, GitHub |
| GraphQL | Query language, get exactly what you need | GitHub v4, Shopify |
| SOAP | XML-based, enterprise | Legacy banking |
| WebSocket | Real-time, bidirectional | Chat apps, live data |

**For data collection, we focus on REST APIs** (most common).

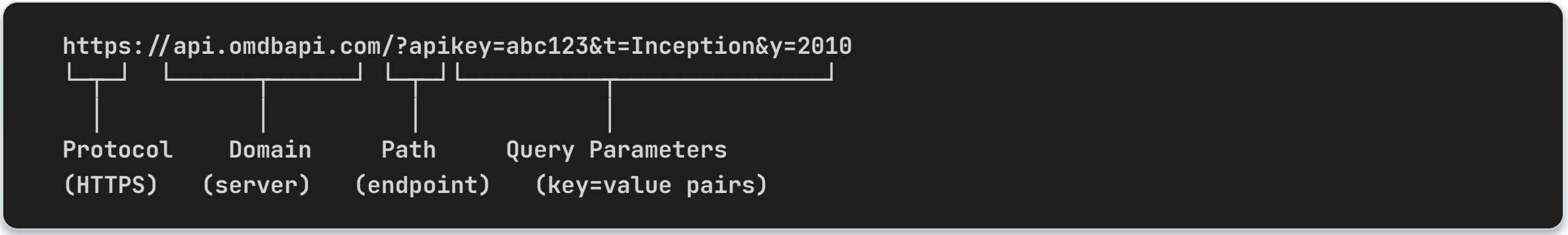
# REST API: Key Principles

**REST** = **RE**presentational **S**tate **T**ransfer

1. **Stateless**: Server doesn't remember previous requests
2. **Resource-based**: URLs represent things (nouns)
3. **HTTP Methods**: Standard verbs (GET, POST, PUT, DELETE)
4. **Standard formats**: JSON or XML responses

```
Good URL Design:
GET  /movies          → List all movies
GET  /movies/123      → Get movie with ID 123
POST /movies          → Create new movie
PUT  /movies/123      → Update movie 123
DELETE /movies/123    → Delete movie 123
```

# Anatomy of an API Call




**Query Parameters** (after the `?`):

- `apikey=abc123` → Authentication
- `t=Inception` → Movie title
- `y=2010` → Year (optional filter)

Multiple parameters joined with `&`

# API Authentication

Most APIs require authentication to:

- Track usage
- Enforce rate limits
- Bill customers

**Common methods:**

```
# 1. API Key in URL (simplest)
GET /movies?apikey=YOUR_KEY

# 2. API Key in Header
GET /movies
X-API-Key: YOUR_KEY

# 3. Bearer Token (OAuth)
GET /movies
Authorization: Bearer YOUR_TOKEN
```

# Rate Limiting

**Why?** Servers have limited resources.

**Rate Limiting Tiers:**

| Tier | Requests/Day |
|---|---|
| Free | 100 |
| Basic | 1,000 |
| Pro | 10,000 |

**If you exceed:** HTTP 429 (Too Many Requests)

**Rate limit headers in response:**

- `X-RateLimit-Limit: 100`
- `X-RateLimit-Remaining: 42`
- `X-RateLimit-Reset: 1623456789`

# Dealing with Rate Limits

**Strategy 1: Simple delay** - Add `time.sleep()` between requests

```
import time

for movie in movies:
    response = requests.get(api_url, params={"t": movie})
    process(response)
```

**Strategy 2: Exponential backoff** - Wait longer after each failure

```
wait_time = 1
while True:
    response = requests.get(url)
    if response.status_code == 429:
        time.sleep(wait_time)
        wait_time *= 2  # Double the wait: 1, 2, 4, 8, 16...
```

**Strategy 3: Check headers** - Use `X-RateLimit-Remaining` to pause proactively

# Part 4: HTTP Fundamentals

*The language of the web*

# What is HTTP?

**HTTP** = **H**yper**T**ext **T**ransfer **P**rotocol

The foundation of data communication on the web.


**Key characteristics:**

- **Stateless**: Each request is independent
- **Text-based**: Human-readable (mostly)
- **Port 80** (HTTP) or **Port 443** (HTTPS)

# Understanding "Stateless"

> **The Goldfish Analogy**: The server has the memory of a goldfish. Every request, it forgets everything about you.

**What stateless means:**

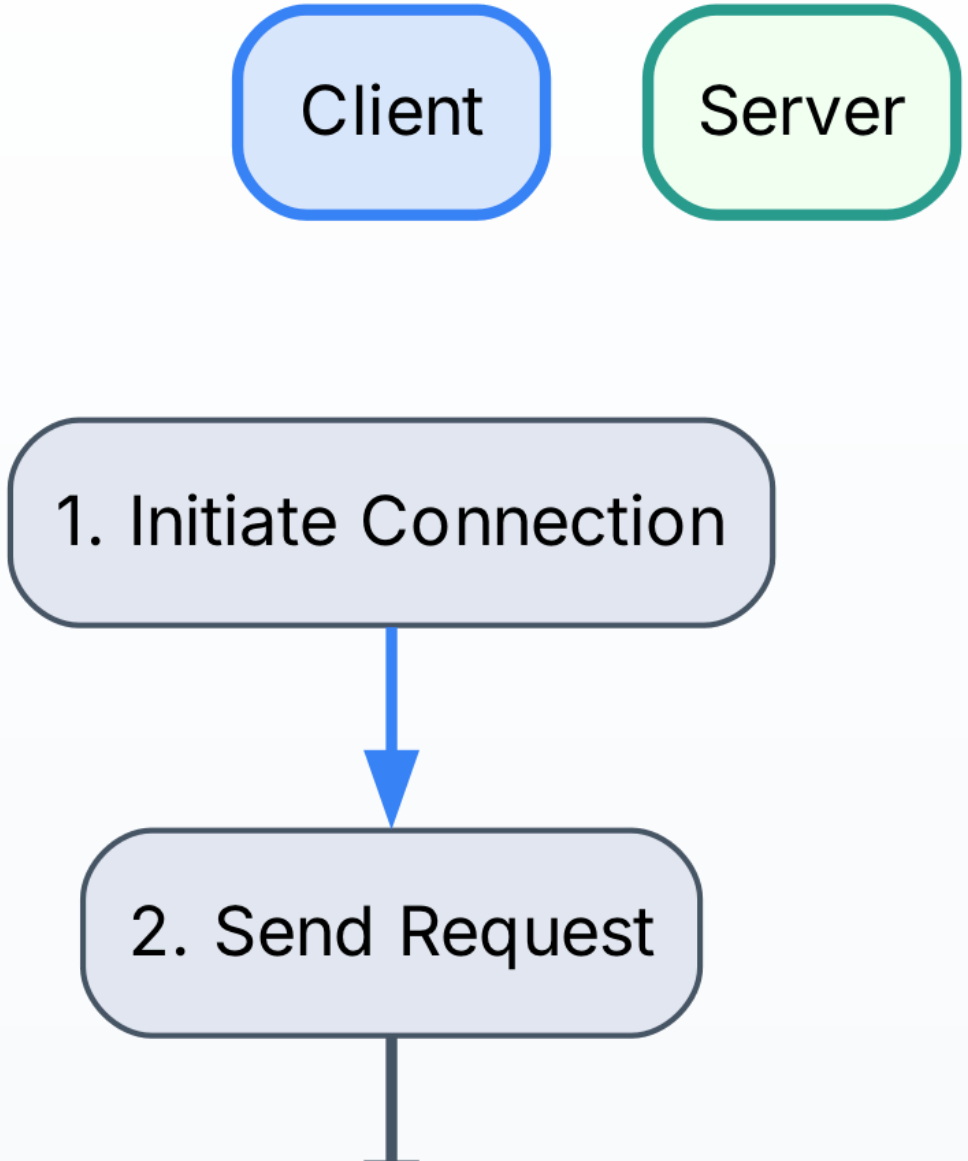
```
Request 1: "Hi, I'm Alice. Show me Inception."
Server: "Here's Inception data."
```

**Why stateless?**

- Servers handle millions of users - can't remember everyone
- Any server can handle any request (scalability)
- Failed requests don't corrupt server state

**How do we work around it?** Cookies, tokens, session IDs (sent with every request)

# The Client-Server Model



# HTTP Request Structure

Every HTTP request has three parts:

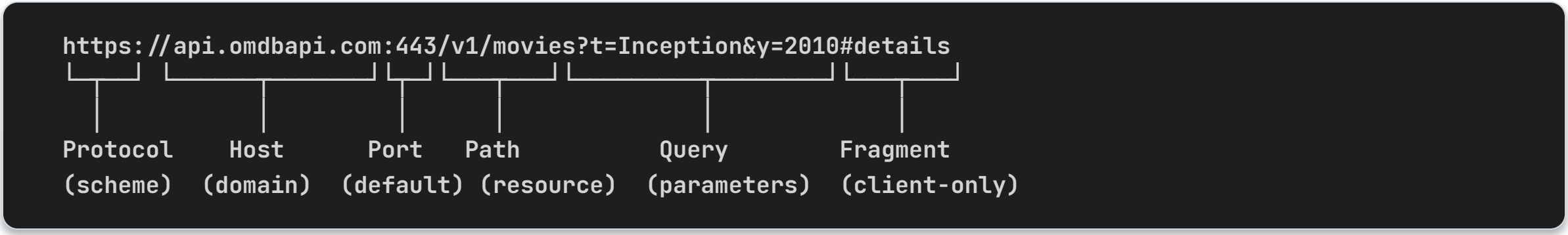
```
1. REQUEST LINE
   GET /movies?t=Inception HTTP/1.1

2. HEADERS
   Host: api.omdbapi.com
   User-Agent: Python/3.9
   Accept: application/json
   Authorization: Bearer abc123

3. BODY (optional, for POST/PUT)
   {"title": "New Movie", "year": 2024}
```

# HTTP Response Structure

Every HTTP response has three parts:

```
1. STATUS LINE
   HTTP/1.1 200 OK

2. HEADERS
   Content-Type: application/json
   Content-Length: 1234
   X-RateLimit-Remaining: 99

3. BODY (the actual data)
   {"Title": "Inception", "Year": "2010", ...}
```

# URL Anatomy




**Components:**

- **Protocol**: `http://` or `https://` (encrypted)
- **Host**: Domain name or IP address
- **Port**: Usually implicit (80 for HTTP, 443 for HTTPS)
- **Path**: Location of resource on server
- **Query**: Parameters as `key=value` pairs
- **Fragment**: Client-side anchor (not sent to server)

# Common HTTP Headers

**Request Headers** (what client sends):

| Header | Purpose | Example |
| --- | --- | --- |
| `Host` | Target server | `api.omdbapi.com` |
| `User-Agent` | Client identification | `Mozilla/5.0` |
| `Accept` | Preferred response format | `application/json` |
| `Authorization` | Authentication | `Bearer token123` |
| `Content-Type` | Body format (POST) | `application/json` |

# Common HTTP Headers (Response)

**Response Headers** (what server sends):

| Header | Purpose | Example |
| --- | --- | --- |
| `Content-Type` | Body format | `application/json` |
| `Content-Length` | Size in bytes | `1234` |
| `Cache-Control` | Caching rules | `max-age=3600` |
| `X-RateLimit-Remaining` | API quota left | `99` |
| `Set-Cookie` | Session cookie | `session=abc123` |

# Part 5: HTTP Methods - GET and POST

*The two most important verbs*

# HTTP Methods Overview

| Method | Purpose | Has Body? | Safe? | Idempotent? |
|---|---|---|---|---|
| GET | Retrieve data | No | Yes | Yes |
| POST | Create/submit data | Yes | No | No |
| PUT | Replace resource | Yes | No | Yes |
| PATCH | Partial update | Yes | No | No |
| DELETE | Remove resource | No | No | Yes |

**For data collection**: 90% GET, 10% POST

# What Do "Safe" and "Idempotent" Mean?

**Safe** = "Looking doesn't change anything" (like window shopping)
**Idempotent** = "Doing it twice has the same effect as once" (like pressing elevator button)

## Real-world examples:

| Action | Safe? | Idempotent? | Why? |
|---|---|---|---|
| Reading a book | Yes | Yes | Book doesn't change |
| Ordering pizza | No | No | Each order = new pizza |
| Setting thermostat to 72° | No | Yes | Twice = still 72° |
| Turning on a light | No | Yes | Already on? Still on |

## Why this matters for APIs:

- GET requests can be cached and retried safely
- POST requests should not be automatically retried (double-charge risk!)

# GET Request: Retrieving Data

**Purpose**: Fetch data without modifying anything.

```
GET /movies?t=Inception&y=2010 HTTP/1.1
Host: api.omdbapi.com
Accept: application/json
```

**Characteristics**:

- Parameters in URL (query string)
- No request body
- **Safe**: Doesn't change server state
- **Idempotent**: Same request = same result
- **Cacheable**: Responses can be cached

# POST Request: Sending Data

**Purpose**: Submit data to create or process something.

```
POST /api/feedback HTTP/1.1
Host: example.com
Content-Type: application/json

{"movie_id": 123, "rating": 5, "review": "Great!"}
```

**Characteristics**:

- Data in request body (not URL)
- **Not safe**: Modifies server state
- **Not idempotent**: Multiple POSTs create multiple resources
- **Not cacheable**

# GET vs POST: When to Use Which

| Scenario | Method | Why |
|---|---|---|
| Fetching movie details | GET | Retrieving data |
| Searching for movies | GET | Query in URL |
| Submitting a review | POST | Creating new data |
| Uploading an image | POST | Sending binary data |
| User login | POST | Sensitive data in body |
| Listing all movies | GET | No modification |

**Data Collection = Mostly GET**

**Data Submission = POST**

# HTTP Status Codes

**Status codes are grouped by category:**

| Range | Category | Meaning |
|---|---|---|
| 1xx | Informational | Request received, processing |
| 2xx | Success | Request succeeded |
| 3xx | Redirection | Further action needed |
| 4xx | Client Error | Your fault |
| 5xx | Server Error | Their fault |

# Common Status Codes

| Code | Meaning | When |
|---|---|---|
| `200 OK` | Success | Request succeeded |
| `201 Created` | Created | POST created resource |
| `400 Bad Request` | Client error | Malformed request |
| `401 Unauthorized` | Auth needed | Missing credentials |
| `403 Forbidden` | Denied | Not allowed |
| `404 Not Found` | Missing | Resource doesn't exist |
| `429 Too Many Requests` | Rate limit | Slow down! |
| `500 Internal Error` | Server crash | Their fault |

# Status Code Intuition

**The first digit tells you who's to blame:**

- **2xx** = Everything worked
- **4xx** = You messed up (fix your request)
- **5xx** = They messed up (try again later)

## How to handle each in your code:

```
if response.status_code == 200:
    data = response.json()              # Success! Process data
elif response.status_code == 404:
    print("Movie not found")            # Your fault - bad ID
elif response.status_code == 429:
    time.sleep(60)                      # Rate limited - wait and retry
elif response.status_code >= 500:
    time.sleep(5)                       # Server error - retry later
```

**Pro tip**: Check `response.ok` for any 2xx status code.

# Part 6: Response Formats

*Same data, different representations*

# Why Different Formats?

Same movie data can be represented in different formats:

| Format | Full Name | Use Case |
|---|---|---|
| JSON | JavaScript Object Notation | APIs, Web apps |
| XML | eXtensible Markup Language | Enterprise, Legacy |
| CSV | Comma Separated Values | Spreadsheets, ML |
| HTML | HyperText Markup Language | Web pages |
| Protobuf | Protocol Buffers | High-performance |

**Content-Type header** tells you the format:

- `application/json` → JSON
- `application/xml` → XML
- `text/html` → HTML
- `text/csv` → CSV

# Format 1: JSON

The most common API format today.

```
{
  "title": "Inception",
  "year": 2010,
  "genres": ["Sci-Fi", "Action", "Thriller"],
  "director": {
    "name": "Christopher Nolan",
    "nationality": "British"
  },
  "rating": 8.8,
  "in_production": false
}
```

Pros: Human-readable, lightweight, native to JavaScript

Cons: No schema validation, no comments

# JSON Data Types

```json
{
  "string": "Hello World",
  "number": 42,
  "decimal": 3.14159,
  "boolean": true,
  "null_value": null,
  "array": [1, 2, 3],
  "object": {
    "nested": "value"
  }
}
```

**Only 7 data types**: string, number, boolean, null, array, object

**Note**: No native date type! Dates are typically strings: `"2010-07-16"`

# JSON Gotchas and Pitfalls

> Common surprises when working with JSON from APIs:

```
# Gotcha 1: Numbers might be strings!
data = {"year": "2010", "rating": "8.8"}  # Both are strings!
year = int(data["year"])                   # Must convert

# Gotcha 2: Missing keys crash your code
data = {"title": "Inception"}
director = data["director"]                # KeyError!
director = data.get("director", "Unknown") # Safe!

# Gotcha 3: null becomes None in Python
data = {"budget": null}   # JSON null
if data["budget"]:        # This is False!
    print("Has budget")

# Gotcha 4: Empty string vs null vs missing key
{"rating": ""}      # Empty string (exists but blank)
{"rating": null}    # Null (explicitly no value)
{}                  # Missing key entirely
```

# Format 2: XML

The enterprise standard (still used in SOAP APIs).

```xml
<?xml version="1.0" encoding="UTF-8"?>
<movie>
  <title>Inception</title>
  <year>2010</year>
  <genres>
    <genre>Sci-Fi</genre>
    <genre>Action</genre>
  </genres>
  <director nationality="British">
    Christopher Nolan
  </director>
  <rating>8.8</rating>
</movie>
```

**Pros**: Schema validation (XSD), attributes, widespread support

**Cons**: Verbose, heavier than JSON

# JSON vs XML: Same Data

| Aspect | JSON | XML |
| --- | --- | --- |
| Syntax | `{"name": "Inception"}` | `<name>Inception</name>` |
| Structure | Curly braces `{}` | Tags `<tag></tag>` |
| Size | Lighter (~30% smaller) | More verbose |
| Attributes | Not supported | Supported |
| Arrays | `[1, 2, 3]` | Repeated elements |
| Usage | Modern APIs | Legacy/Enterprise |

# Format 3: CSV

The data scientist's friend.

```
title,year,genre,director,rating
Inception,2010,Sci-Fi,Christopher Nolan,8.8
Avatar,2009,Action,James Cameron,7.8
```

Pros:

- Opens in Excel/Google Sheets
- Easy to load into pandas: `pd.read_csv("movies.csv")`
- Very compact

Cons:

- Flat structure only (no nesting)
- No data types (everything is text)
- Escaping issues with commas in data

# Format 4: HTML

What you get when scraping websites.

```
<div class="movie-card">
  <h2 class="title">Inception</h2>
  <span class="year">2010</span>
  <ul class="genres">
    <li>Sci-Fi</li>
    <li>Action</li>
  </ul>
  <p class="rating">Rating: 8.8/10</p>
</div>
```

Not designed for data exchange!

- Mixed with presentation (CSS, layout)
- Need to parse and extract relevant data
- Structure varies by website

# Format 5: Protocol Buffers (Protobuf)

Google's high-performance binary format.

```
// movie.proto (schema definition)
message Movie {
  string title = 1;
  int32 year = 2;
  repeated string genres = 3;
  float rating = 4;
}
```

Binary on the wire (not human-readable):

```
0a 09 49 6e 63 65 70 74 69 6f 6e 10 da 0f ...
```

Pros: 10x smaller, 100x faster parsing

Cons: Need schema, binary format, requires tooling

# Format Comparison: Same Movie

| Format | Size | Readability | Use Case |
|---|---|---|---|
| JSON | 150 bytes | High | REST APIs |
| XML | 200 bytes | Medium | Enterprise |
| CSV | 50 bytes | High | Data exchange |
| HTML | 300 bytes | Low | Web pages |
| Protobuf | 30 bytes | None | High-perf APIs |

**For this course**: Focus on JSON and HTML

# Part 7: Chrome DevTools

*Your window into HTTP traffic*

# Why Chrome DevTools?

**DevTools lets you see:**

- Every HTTP request your browser makes
- Request headers, body, timing
- Response headers, body, status codes
- Copy requests as curl commands!

**This is how you learn what APIs a website uses.**

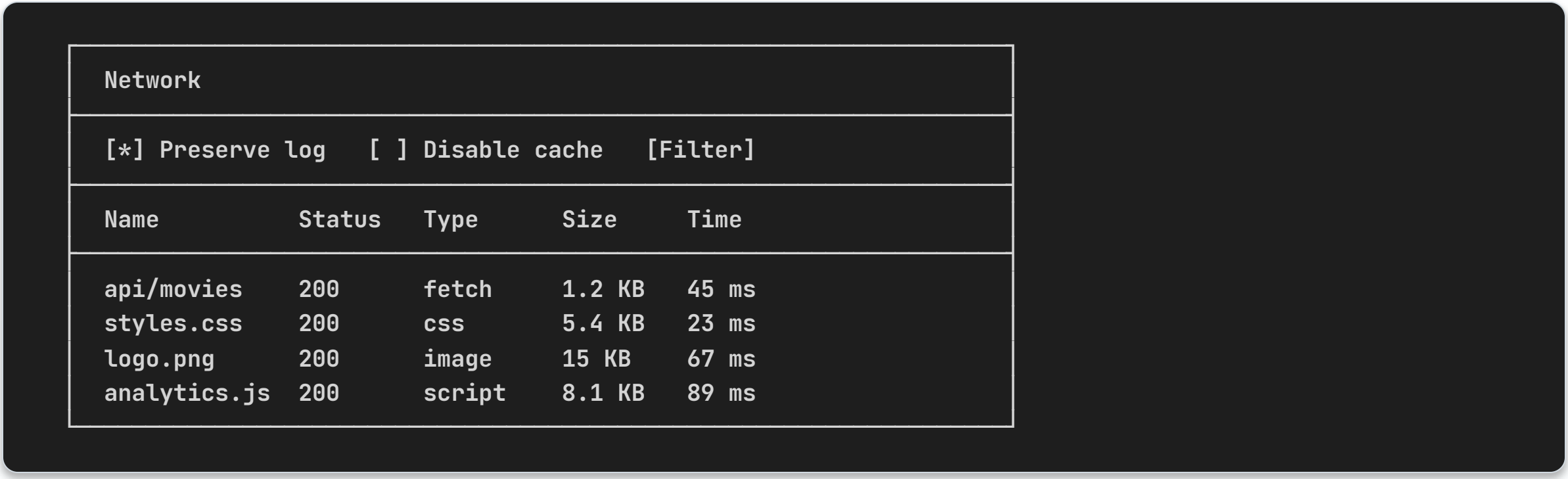
# Opening DevTools

**Three ways to open:**

1. **Keyboard**: `F12` or `Ctrl+Shift+I` (Windows/Linux) / `Cmd+Option+I` (Mac)
2. **Right-click**: Right-click on page → "Inspect"
3. **Menu**: Chrome menu → More Tools → Developer Tools

**Navigate to the "Network" tab**

# The Network Tab




Every row = one HTTP request/response

# Filtering Requests

## Filter by type:

| Filter | Shows |
| --- | --- |
| All | Everything |
| Fetch/XHR | API calls (AJAX) ← Most useful! |
| Doc | HTML documents |
| CSS | Stylesheets |
| JS | JavaScript files |
| Img | Images |

## Click "Fetch/XHR" to see only API calls

# Inspecting a Request

Click on any request to see details:

```
Headers   Preview   Response   Timing   Cookies

General:
  Request URL: https://api.example.com/movies?id=123
  Request Method: GET
  Status Code: 200 OK

Response Headers:
  content-type: application/json
  x-ratelimit-remaining: 99

Request Headers:
  authorization: Bearer eyJhbGc...
  user-agent: Mozilla/5.0...
```

# The Preview & Response Tabs

**Preview Tab**: Formatted JSON viewer

```
{
  "title": "Inception",
  "year": 2010,
  "rating": 8.8
}
```

**Response Tab**: Raw response body

```
{"title":"Inception","year":2010,"rating":8.8}
```

# Copy as curl

**The most powerful feature!**

1. Right-click on any request
2. Select "Copy" → "Copy as cURL"
3. Paste into terminal

```
curl 'https://api.example.com/movies?id=123' \
  -H 'accept: application/json' \
  -H 'authorization: Bearer eyJhbGciOiJIUzI1...' \
  -H 'user-agent: Mozilla/5.0 (Macintosh...)' \
  --compressed
```

**Now you can replay the exact request from your terminal!**

# Demo: Finding Hidden APIs

**Many websites use hidden APIs. Here's how to find them:**

1. Open DevTools → Network tab
2. Filter by "Fetch/XHR"
3. Interact with the website (search, click, load more)
4. Watch for API calls appearing in the list
5. Click on interesting requests to inspect them
6. Copy as curl to test in terminal

**Example**: Search on IMDb and watch for API calls...

# DevTools Pro Tips

**Preserve log**: Keep requests when navigating between pages

**Disable cache**: See fresh requests every time

**Search**: `Ctrl+F` to search in all requests

**Filter by URL**: Type in filter box to match URLs

**Clear**: Click the clear icon to clear all requests

**Throttling**: Simulate slow networks (3G, offline)

# Part 8: Making Requests with curl

*The command-line HTTP client*

# What is curl?

**curl** = "Client URL" - a command-line tool for transferring data.

```
# Your first curl command
curl "https://api.omdbapi.com/?apikey=demo&t=Inception"
```

## Why learn curl?

- Universal (works everywhere)
- Quick debugging
- Foundation for understanding HTTP
- Copy from DevTools, paste and run

# curl: Basic Syntax

```
curl [options] [URL]
```

## Common options:

| Option | Meaning | Example |
|---|---|---|
| `-X` | HTTP method | `-X POST` |
| `-H` | Add header | `-H "Accept: application/json"` |
| `-d` | Send data (body) | `-d '{"key": "value"}'` |
| `-o` | Output to file | `-o movie.json` |
| `-I` | Headers only | `-I` |
| `-v` | Verbose output | `-v` |
| `-s` | Silent mode | `-s` |

# curl: GET Request

```
# Simple GET request
curl "https://api.omdbapi.com/?apikey=demo&t=Inception"
```

**Output:**

```
{"Title":"Inception","Year":"2010","Rated":"PG-13",
"Released":"16 Jul 2010","Runtime":"148 min",...}
```

**Important**: Quote the URL! (prevents shell interpretation of `&`)

# curl: Adding Headers

```
curl "https://api.example.com/movies" \
     -H "Accept: application/json" \
     -H "Authorization: Bearer YOUR_TOKEN" \
     -H "User-Agent: MyApp/1.0"
```

Common headers to add:

- `Accept: application/json` - Request JSON response
- `Authorization: Bearer TOKEN` - Authentication
- `Content-Type: application/json` - When sending JSON

# curl: Viewing Response Headers

```
# Show only response headers (no body)
curl -I "https://api.omdbapi.com/?apikey=demo&t=Inception"
```

Output:

```
HTTP/1.1 200 OK
Content-Type: application/json; charset=utf-8
Content-Length: 1024
Cache-Control: public, max-age=86400
X-RateLimit-Remaining: 999
```

# curl: Verbose Mode

```
curl -v "https://api.omdbapi.com/?apikey=demo&t=Inception"
```

**Shows everything (request AND response):**

```
> GET /?apikey=demo&t=Inception HTTP/2
> Host: api.omdbapi.com
> User-Agent: curl/7.79.1
> Accept: */*
>
< HTTP/2 200
< content-type: application/json
< content-length: 1024
<
{"Title":"Inception"...}
```

`>` = What you sent (request)

`<` = What you received (response)

# Pretty Printing with jq

Raw JSON is hard to read. Pipe to `jq` for formatting:

```
curl -s "https://api.omdbapi.com/?apikey=demo&t=Inception" | jq .
```

Output (formatted):

```
{
  "Title": "Inception",
  "Year": "2010",
  "Rated": "PG-13",
  "Runtime": "148 min",
  "Genre": "Action, Adventure, Sci-Fi"
}
```

# jq: Extracting Specific Fields

```
# Get just the title
curl -s ... | jq '.Title'
# Output: "Inception"

# Get multiple fields as new object
curl -s ... | jq '{title: .Title, year: .Year, rating: .imdbRating}'
# Output: {"title": "Inception", "year": "2010", "rating": "8.8"}

# Get first element of array
curl -s ... | jq '.Search[0]'

# Get all titles from array
curl -s ... | jq '.Search[].Title'
```

# curl: Saving to File

```
# Save response to file
curl "https://api.omdbapi.com/?apikey=demo&t=Inception" \
     -o inception.json

# Silent mode (no progress bar)
curl -s "https://api.example.com/data" -o output.json

# Save with pretty formatting
curl -s ... | jq . > formatted.json
```

# curl: POST Request

```
curl -X POST "https://api.example.com/reviews" \
     -H "Content-Type: application/json" \
     -H "Authorization: Bearer YOUR_TOKEN" \
     -d '{"movie_id": 123, "rating": 5, "review": "Amazing!"}'
```

**Components:**

- `-X POST` - Use POST method
- `-H "Content-Type: application/json"` - Tell server we're sending JSON
- `-d '...'` - The data (request body)

# curl: POST with Form Data

```
# Form-encoded data (like HTML forms)
curl -X POST "https://example.com/login" \
     -d "username=john" \
     -d "password=secret"

# Equivalent to:
curl -X POST "https://example.com/login" \
     -H "Content-Type: application/x-www-form-urlencoded" \
     -d "username=john&password=secret"
```

# curl: File Upload

```
# Upload a file
curl -X POST "https://api.example.com/upload" \
     -F "file=@/path/to/image.jpg" \
     -F "description=My photo"
```

`-F` = multipart form data (for file uploads)
`@` = read from file

# curl: Useful Options

```
# Retry on failure
curl --retry 3 "https://api.example.com/data"

# Set timeout (seconds)
curl --max-time 10 "https://api.example.com/slow"

# Follow redirects
curl -L "https://short.url/abc"

# Fail silently on HTTP errors
curl -f "https://api.example.com/notfound"
# (exits with error code instead of showing error page)
```

# Part 9: Python requests Library

*Programmatic data collection*

# Why Python requests?

**curl is great for testing, but for automation you need Python.**

```
# Install
pip install requests
```

**Benefits over curl:**

- Loop over many URLs
- Parse JSON automatically
- Handle errors gracefully
- Store data in variables
- Integrate with pandas, ML pipelines

# requests: Simple GET

```python
import requests

# Make the request
response = requests.get(
    "https://api.omdbapi.com/",
    params={"apikey": "demo", "t": "Inception"}
)

# Check status
print(response.status_code)  # 200

# Get JSON data
data = response.json()
print(data["Title"])  # "Inception"
print(data["Year"])   # "2010"
```

# requests: Using params

Don't manually build query strings!

```
# Bad (manual string building)
url = "https://api.omdbapi.com/?apikey=demo&t=Inception&y=2010"

# Good (use params dict)
response = requests.get(
    "https://api.omdbapi.com/",
    params={
        "apikey": "demo",
        "t": "Inception",
        "y": 2010
    }
)
```

Python handles URL encoding automatically!

# requests: Adding Headers

```
response = requests.get(
    "https://api.example.com/movies",
    headers={
        "Authorization": "Bearer YOUR_TOKEN",
        "Accept": "application/json",
        "User-Agent": "MyApp/1.0"
    }
)
```

# requests: Response Object

```
response = requests.get("https://api.omdbapi.com/...")

# Status code
response.status_code        # 200

# Headers (dict-like)
response.headers["Content-Type"]  # "application/json"

# Body as text
response.text               # '{"Title": "Inception"...}'

# Body as JSON (parsed dict)
response.json()             # {"Title": "Inception", ...}

# Was it successful?
response.ok                 # True (for 2xx status codes)
```

# requests: POST with JSON

```python
import requests

response = requests.post(
    "https://api.example.com/reviews",
    headers={
        "Authorization": "Bearer YOUR_TOKEN"
    },
    json={  # Use json= for automatic JSON encoding
        "movie_id": 123,
        "rating": 5,
        "review": "Great movie!"
    }
)

if response.status_code == 201:
    print("Review submitted!")
    print(response.json())
```

# requests: POST with Form Data

```
# Form-encoded POST (like HTML forms)
response = requests.post(
    "https://example.com/login",
    data={  # Use data= for form encoding
        "username": "john",
        "password": "secret"
    }
)
```

**Remember:**

- `json=` → Content-Type: application/json
- `data=` → Content-Type: application/x-www-form-urlencoded

# requests: Error Handling

```python
import requests

try:
    response = requests.get(
        "https://api.omdbapi.com/",
        params={"apikey": "demo", "t": "Inception"},
        timeout=10  # seconds
    )

    # Raise exception for 4xx/5xx status codes
    response.raise_for_status()

    data = response.json()

except requests.exceptions.Timeout:
    print("Request timed out")
except requests.exceptions.HTTPError as e:
    print(f"HTTP error: {e}")
except requests.exceptions.RequestException as e:
    print(f"Request failed: {e}")
```

# requests: Looping Over Multiple Items

```python
import requests
import time

movies = ["Inception", "Avatar", "The Matrix", "Interstellar"]
results = []

for title in movies:
    response = requests.get(
        "https://api.omdbapi.com/",
        params={"apikey": "YOUR_KEY", "t": title}
    )

    if response.ok:
        results.append(response.json())
        print(f"Got: {title}")

    time.sleep(0.5)  # Be nice to the server!

print(f"Collected {len(results)} movies")
```

# requests: Session for Multiple Requests

```
import requests

# Session persists settings across requests
session = requests.Session()
session.headers.update({
    "Authorization": "Bearer YOUR_TOKEN",
    "User-Agent": "MyApp/1.0"
})

# Now all requests use these headers
r1 = session.get("https://api.example.com/movies")
r2 = session.get("https://api.example.com/reviews")
r3 = session.get("https://api.example.com/users")

# Also maintains cookies automatically!
```

# requests: Practical Example

```python
import requests
import pandas as pd

def fetch_movie_data(titles, api_key):
    """Fetch movie data for a list of titles."""
    movies = []

    for title in titles:
        response = requests.get(
            "https://api.omdbapi.com/",
            params={"apikey": api_key, "t": title},
            timeout=10
        )

        if response.ok and response.json().get("Response") == "True":
            movies.append(response.json())

    return pd.DataFrame(movies)

# Usage
df = fetch_movie_data(["Inception", "Avatar"], "YOUR_KEY")
print(df[["Title", "Year", "imdbRating"]])
```

# Data Collection Best Practices

> **The 5 Rules of Robust Data Collection:**

1. **Save raw responses** - Don't just extract fields; save the full JSON

```
with open(f"raw/{movie_id}.json", "w") as f:
    json.dump(response.json(), f)
```

2. **Log everything** - Track what succeeded, what failed, and why
3. **Use checkpoints** - Save progress so you can resume after crashes
4. **Handle edge cases** - Movies with no budget, missing directors, etc.
5. **Validate as you go** - Check data types and required fields early

**Why?** You don't want to re-collect 10,000 movies because you missed a field!

# curl vs requests: Comparison

| Aspect | curl | Python requests |
|---|---|---|
| Use case | Quick testing | Automation |
| Learning | Interactive exploration | Production code |
| Looping | Bash scripts | Native Python |
| JSON parsing | Needs jq | Built-in .json() |
| Error handling | Exit codes | Exceptions |
| DevTools | Copy as curl (yes) | Convert from curl |

**Workflow**: DevTools → Copy as curl → Test → Convert to Python

# Part 10: Web Scraping

*When APIs don't exist*

# When to Scrape?

**DO scrape when:**

- No API available
- API doesn't have the data you need
- API is too expensive
- Public information on public websites

**DON'T scrape when:**

- robots.txt disallows it
- Terms of Service prohibit it
- Data is behind login (personal data)
- It would harm the website

# API vs Scraping Comparison

| Aspect | API | Scraping |
| --- | --- | --- |
| **Reliability** | Stable | Fragile (HTML changes) |
| **Speed** | Fast | Slower |
| **Data Format** | Structured JSON | Unstructured HTML |
| **Rate Limits** | Documented | Unknown |
| **Legality** | Clear TOS | Gray area |
| **Maintenance** | Low | High |

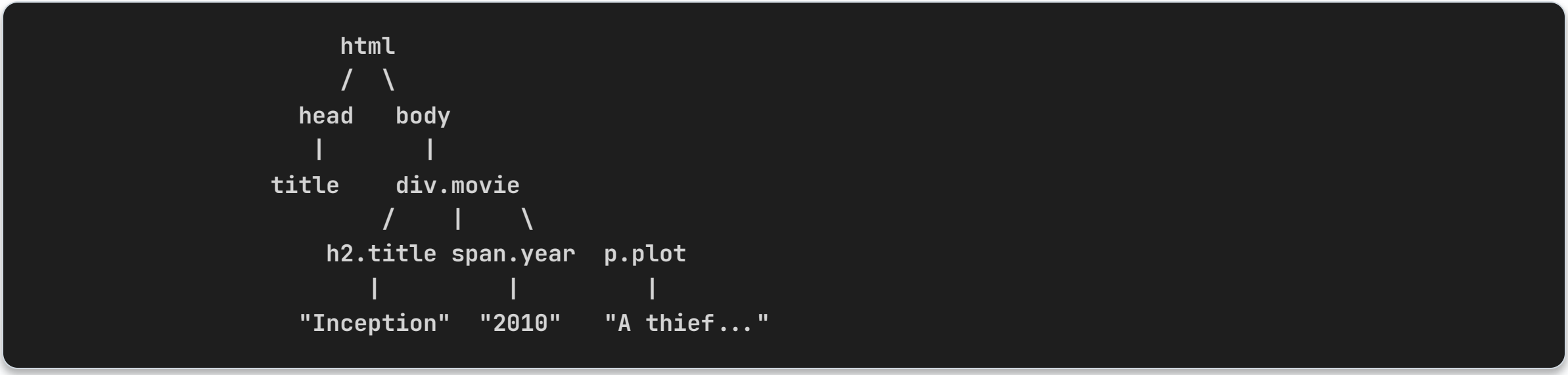
**Rule**: Always prefer APIs when available.

# HTML Structure Basics

HTML = Nested elements forming a tree (DOM)

```
<!DOCTYPE html>
<html>
  <head>
    <title>Movie Database</title>
  </head>
  <body>
    <div class="movie" id="movie-123">
      <h2 class="title">Inception</h2>
      <span class="year">2010</span>
      <p class="plot">A thief who steals...</p>
    </div>
  </body>
</html>
```

# The DOM Tree




**DOM** = Document Object Model

**Scraping** = Navigating this tree to extract data

# CSS Selectors: Finding Elements

| Selector | Meaning | Example Match |
| --- | --- | --- |
| `div` | Element type | `<div>...</div>` |
| `.movie` | Class name | `<div class="movie">` |
| `#main` | Element ID | `<div id="main">` |
| `div.movie` | Tag with class | `<div class="movie">` |
| `.movie .title` | Nested element | `.title` inside `.movie` |
| `a[href="/movies"]` | Attribute value | `<a href="/movies">` |

# BeautifulSoup: Setup

```
pip install beautifulsoup4 requests
```

```
from bs4 import BeautifulSoup
import requests

# Fetch the page
response = requests.get("https://example.com/movies")
html = response.text

# Parse it
soup = BeautifulSoup(html, 'html.parser')

# Now we can search!
```

# BeautifulSoup: Finding Elements

```
from bs4 import BeautifulSoup

html = """
<div class="movie">
  <h2 class="title">Inception</h2>
  <span class="year">2010</span>
  <span class="rating">8.8</span>
</div>
"""

soup = BeautifulSoup(html, 'html.parser')

# Find single element
title = soup.find('h2', class_='title')
print(title.text)  # "Inception"

# Find all elements
all_movies = soup.find_all('div', class_='movie')
```

# BeautifulSoup: CSS Selectors

```
soup = BeautifulSoup(html, 'html.parser')

# Select first match
title = soup.select_one('.movie .title')
print(title.text)  # "Inception"

# Select all matches
all_titles = soup.select('.movie .title')
for t in all_titles:
    print(t.text)

# Complex selectors
links = soup.select('a[href^="/movies/"]')  # href starts with
```

# BeautifulSoup: Extracting Data

```
# Get text content
element.text           # "Inception"
element.get_text()     # Same, with options
element.get_text(strip=True)  # Remove whitespace

# Get attribute
link = soup.select_one('a')
link.get('href')       # "/movies/123"
link['href']           # Same thing

# Get all attributes
link.attrs             # {'href': '/movies/123', 'class': ['btn']}
```

# Scraping Example: Movie List

```
import requests
from bs4 import BeautifulSoup

url = "https://example.com/top-movies"
response = requests.get(url)
soup = BeautifulSoup(response.text, 'html.parser')

movies = []
for card in soup.select('.movie-card'):
    movie = {
        'title': card.select_one('.title').text.strip(),
        'year': card.select_one('.year').text.strip(),
        'rating': card.select_one('.rating').text.strip(),
    }
    movies.append(movie)

print(f"Found {len(movies)} movies")
```

# Handling Pagination

```
import requests
from bs4 import BeautifulSoup
import time

base_url = "https://example.com/movies?page="
all_movies = []

for page in range(1, 11):  # Pages 1-10
    response = requests.get(f"{base_url}{page}")
    soup = BeautifulSoup(response.text, 'html.parser')

    movies = soup.select('.movie-card')
    if not movies:
        break  # No more pages

    for m in movies:
        all_movies.append(m.select_one('.title').text)

    print(f"Page {page}: {len(movies)} movies")
    time.sleep(1)  # Be polite!
```

# Scraping Ethics & Best Practices

```
import time
import requests

headers = {
    'User-Agent': 'MyBot/1.0 (contact@example.com)'
}

for url in urls:
    response = requests.get(url, headers=headers)
```

**Rules:**

1. Check `robots.txt` first
2. Add delays between requests
3. Identify yourself (User-Agent)
4. Cache responses when possible
5. Respect rate limits

# Common Scraping Mistakes

**Mistakes that will break your scraper (or get you blocked):**

| Mistake | Problem | Solution |
|---|---|---|
| No delays | Server blocks you | Add `time.sleep(1)` |
| Hardcoded selectors | Site changes, code breaks | Use flexible selectors, handle missing elements |
| No error handling | One bad page crashes everything | Wrap in try/except |
| Ignoring encoding | Garbled text: "CafÃ©" | Use `response.encoding` |
| Not saving raw HTML | Can't debug later | Save HTML before parsing |

```
# Good pattern: defensive scraping
try:
    title = card.select_one('.title')
    movie['title'] = title.text.strip() if title else "Unknown"
except Exception as e:
    logging.error(f"Failed to parse: {url}, error: {e}")
```

# Checking robots.txt

```
curl https://www.imdb.com/robots.txt
```

```
User-agent: *
Disallow: /search/
Disallow: /ap/
Allow: /title/
Crawl-delay: 1
```

**Meaning:**

- Cannot scrape `/search/` pages
- Can scrape `/title/` pages (movie pages)
- Wait 1 second between requests

# Part 11: Putting It All Together

*Back to our Netflix mission*

# Remember Our Goal?

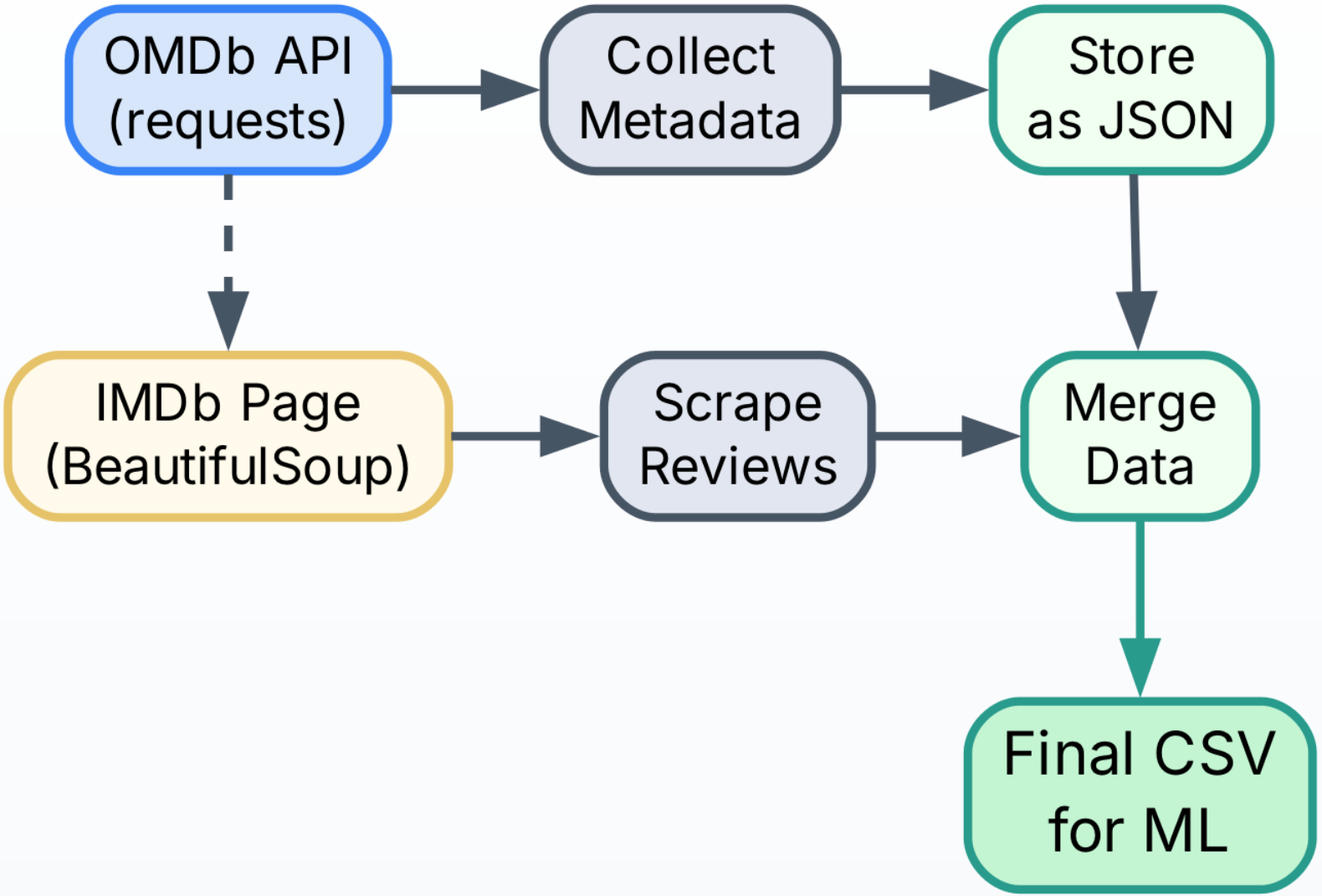
**Build a dataset for movie success prediction:**

| Title | Year | Genre | Budget | Revenue | Rating | Director |
|---|---|---|---|---|---|---|
| ? | ? | ? | ? | ? | ? | ? |

**We now have the tools!**

- **DevTools** to find APIs
- **curl** to test requests
- **requests** to automate collection
- **BeautifulSoup** for scraping

# Our Data Collection Pipeline



# Step 1: Collect from API

```
import requests
import time

API_KEY = "your_omdb_key"
movies_to_fetch = ["Inception", "Avatar", "The Matrix"]
results = []

for title in movies_to_fetch:
    response = requests.get(
        "https://api.omdbapi.com/",
        params={"apikey": API_KEY, "t": title}
    )

    if response.ok:
        data = response.json()
        if data.get("Response") == "True":
            results.append(data)

    time.sleep(0.5)  # Rate limiting

print(f"Collected {len(results)} movies")
```

# Step 2: Extract Relevant Fields

```
movies = []

for data in results:
    movie = {
        "title": data.get("Title"),
        "year": data.get("Year"),
        "genre": data.get("Genre"),
        "director": data.get("Director"),
        "rating": data.get("imdbRating"),
        "votes": data.get("imdbVotes"),
        "runtime": data.get("Runtime"),
        "imdb_id": data.get("imdbID")
    }
    movies.append(movie)
```

# Step 3: Save to CSV

```
import pandas as pd

# Convert to DataFrame
df = pd.DataFrame(movies)

# Clean data
df['year'] = pd.to_numeric(df['year'], errors='coerce')
df['rating'] = pd.to_numeric(df['rating'], errors='coerce')
df['votes'] = df['votes'].str.replace(',', '').astype(float)

# Save
df.to_csv('netflix_movie_data.csv', index=False)

print(df.head())
```

# The Result

```
          title  year                  genre            director  rating
0     Inception  2010  Action, Adventure...  Christopher Nolan     8.8
1        Avatar  2009  Action, Adventure...       James Cameron     7.9
2   The Matrix  1999  Action, Sci-Fi        Lana Wachowski...     8.7
```

Now ready for ML modeling!

# What We Learned: Three Tools

| Tool | When to Use | Key Commands |
|---|---|---|
| Chrome DevTools | Discover APIs, inspect requests | Network tab, Copy as curl |
| curl | Test requests quickly | `-X`, `-H`, `-d`, ` |
| Python requests | Automate collection | `.get()`, `.post()`, `.json()` |

Plus BeautifulSoup for scraping when needed!

# Part 12: Looking Ahead

*Lab preview and next week*

# This Week's Lab

**Hands-on Practice:**

1. **Chrome DevTools** - Inspect API calls on real websites
2. **curl exercises** - Making API requests from terminal
3. **OMDb API** - Collecting movie metadata
4. **Python requests** - Building a data collection script
5. **BeautifulSoup** - Scraping a sample website

**Goal**: Build a working data collection pipeline.

# Lab Environment Setup

```
# Install dependencies
pip install requests beautifulsoup4 pandas

# Get your API keys
# OMDb: https://www.omdbapi.com/apikey.aspx (free tier)

# Verify installation
python -c "import requests; print('Ready!')"
```

# Next Week Preview

## Week 2: Data Validation & Cleaning

- Schema validation with Pydantic
- Handling missing data
- Type conversion and normalization
- Data quality checks
- Building validation pipelines

**The data we collect today needs cleaning tomorrow!**

# Key Takeaways

1. **Data collection is 80% of ML work** - don't underestimate it
2. **DevTools reveals hidden APIs** - always check before scraping
3. **curl for quick testing** - then convert to Python
4. **requests for automation** - handle loops, errors, storage
5. **Scraping is plan B** - use when APIs don't exist
6. **Be ethical** - respect robots.txt, rate limits, ToS

# Resources

## Documentation:

- curl: https://curl.se/docs/
- requests: https://requests.readthedocs.io/
- BeautifulSoup: https://beautiful-soup-4.readthedocs.io/

## Free APIs for Practice:

- JSONPlaceholder: https://jsonplaceholder.typicode.com/
- OMDb: https://www.omdbapi.com/
- Public APIs list: https://github.com/public-apis/public-apis

# Questions?

# Thank You!

See you in the lab!