Exploring Browser Automation: A Comparative Study of Selenium, Cypress, Puppeteer, and Playwright

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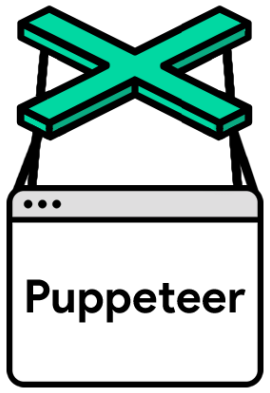
Introduction

- **Browser automation** refers to the use of software to perform tasks in a web browser automatically
  - A common technique is through an **API** (i.e., programmatically)



Playwright

Selenium – What is Selenium?

- Selenium WebDriver (often known as simply **Selenium**) is a multilanguage **browser automation library**

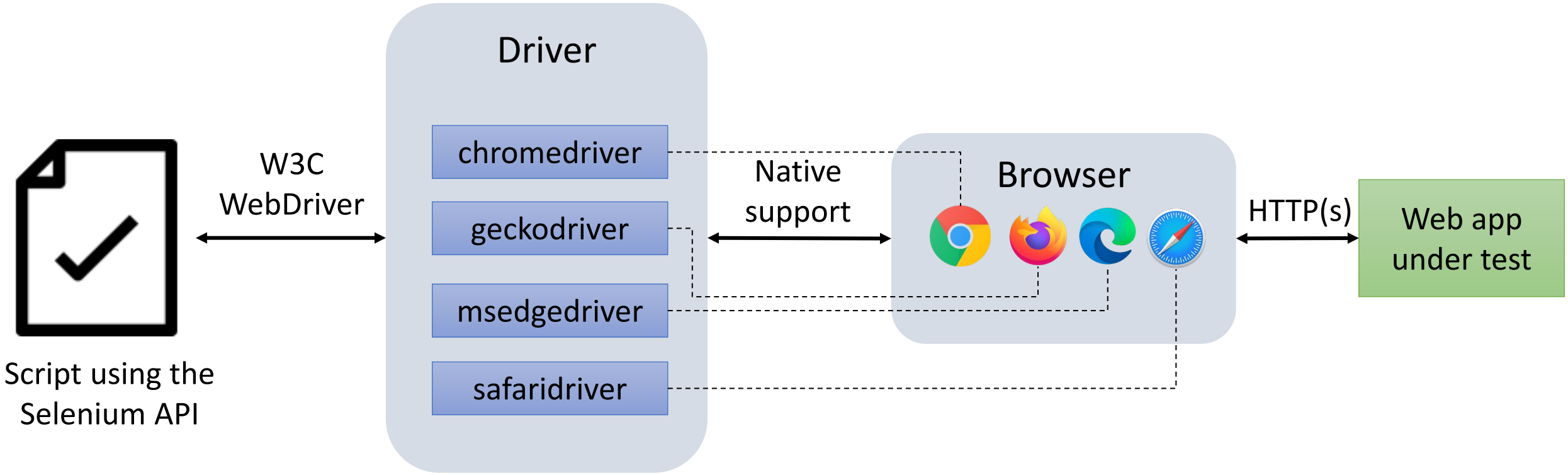
https://selenium.dev/

  - Maintained by the Selenium project since 2004
  - Languages: officially supported in Java, JavaScript, Python, .Net, and Ruby

  - Browsers: any browser with a driver compliant with W3C WebDriver

Selenium – Architecture

Selenium



Cypress – What is Cypress?

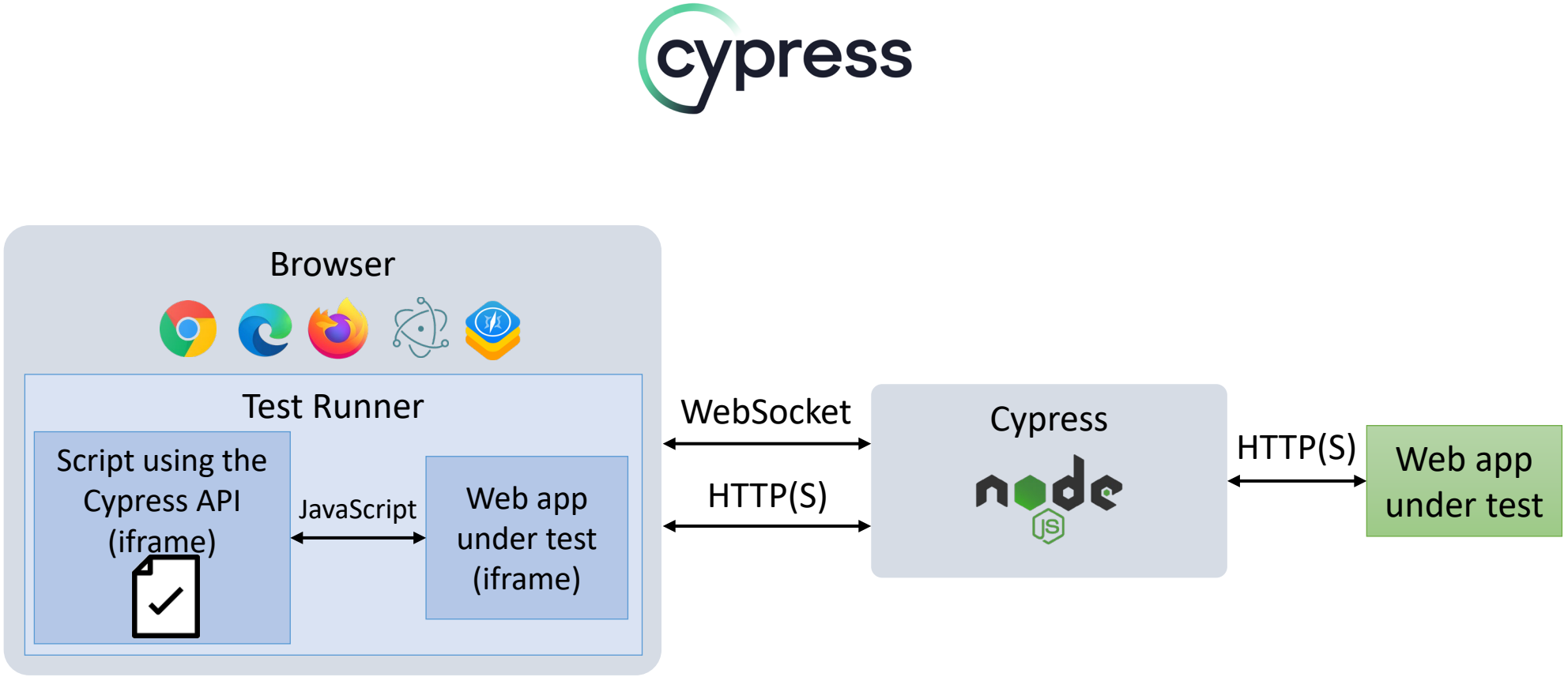
- **Cypress** is a JavaScript **end-to-end automated testing framework**

https://www.cypress.io/

  - Created as a company in 2014 to provide a seamless experience for automated web testing
  - Language: JavaScript

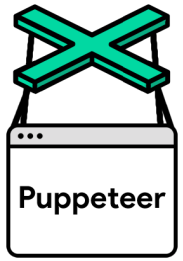
  - Browsers: Chromium-based browsers (like Chrome and Edge), Firefox, WebKit (experimental)

Cypress – Architecture



Puppeteer – What is Puppeteer?

- **Puppeteer** is a Node.js **browser automation library**

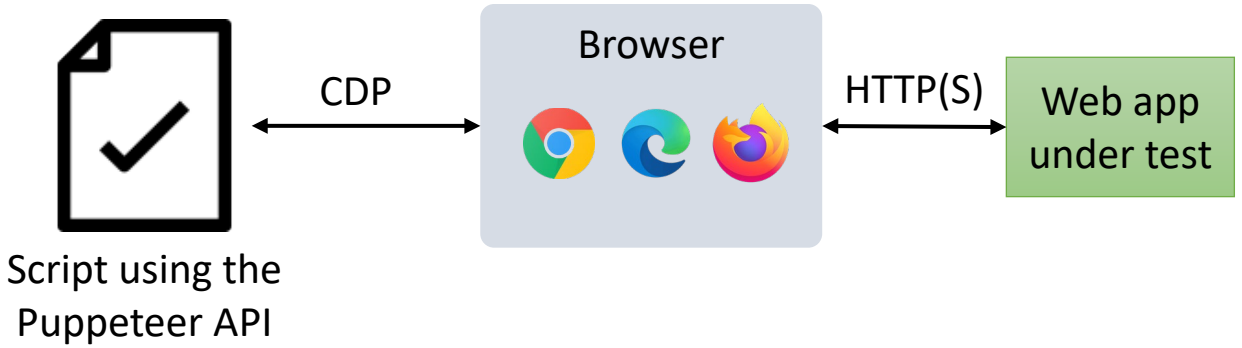


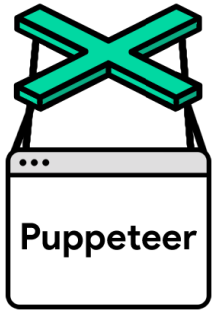
https://pptr.dev/

  - Created and maintained by the Chrome DevTools team at Google since 2017
  - Language: JavaScript or TypeScript

  - Browsers: Chromium-based browsers (like Chrome and Edge) and Firefox (experimental)

Puppeteer – Architecture





Playwright – What is Playwright?

- **Playwright** is a multilanguage **end-to-end automated testing framework**

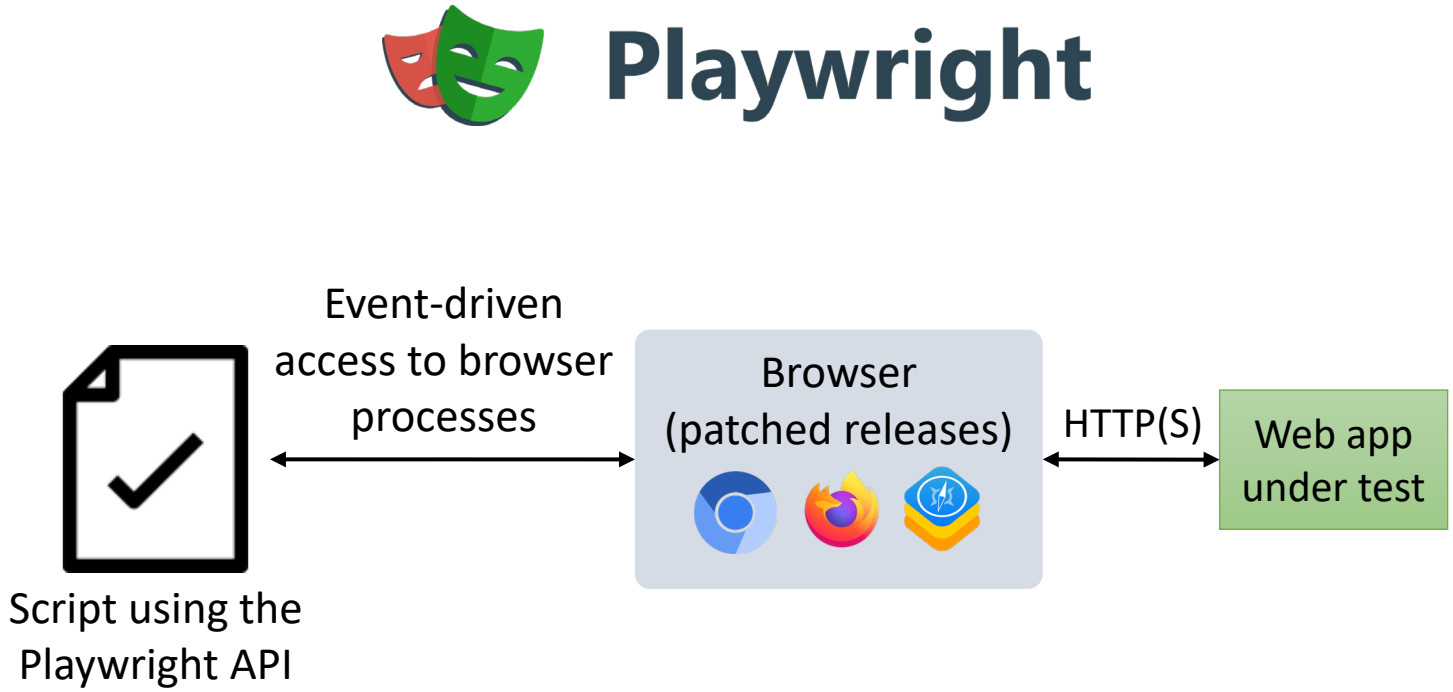
Playwright

https://playwright.dev/

  - Maintained by Microsoft since 2020, when the original team behind Puppeteer moved from Google to Microsoft
  - Languages: JavaScript, TypeScript, Python, .Net, and Java

  - Browsers: Patched releases of Chromium, Firefox, and WebKit

Playwright – Architecture



Features Comparison

Feature	Selenium	Cypress	Puppeteer	Playwright
Multilanguage	✓	X	X	✓
Cross-browser	✓	P	P	P
Automatic waiting	X	✓	X	✓
Tabs handling	✓	X	✓	✓
Frames and iframes	✓	P	✓	✓
Console log gathering	P	X	✓	✓
Session recording	X	P	✓	✓
Assertions	X	✓	X	✓
Live reload	X	✓	X	X
Test retries	X	✓	X	X
Visual testing	X	P	X	✓
Component testing	X	✓	X	P
REST API testing	X	✓	X	✓

Conclusions

	Selenium	Cypress	Puppeteer	Playwright
Pros	• Multilanguage • Cross-browser, since it is entirely based on open standards (WebDriver/BiDi) • Rich ecosystem	• The test and app run in the same browser, providing fast execution and automatic waiting • Built-in high-level testing features	• Comprehensive automation capabilities due to direct communication with the browser using CDP and BiDi	• Multilanguage • Built-in high-level testing features
Cons	• Specific operations (e.g., explicit wait) should be individually handled (or using high-level frameworks belonging to its ecosystem) • Does not provides specific features for testing	• Because the app is run in a iframe, some actions are restricted (e.g. use different browsers or multiple tabs) • Limited cross-browser support • Only supports JavaScript	• Specific operations should be individually handled • Limited cross-browser support • Limited language support • Does not provides specific features for testing	• Rather than actual releases, it uses patched browser versions of Chrome, Firefox, and WebKit

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Thank you very much!

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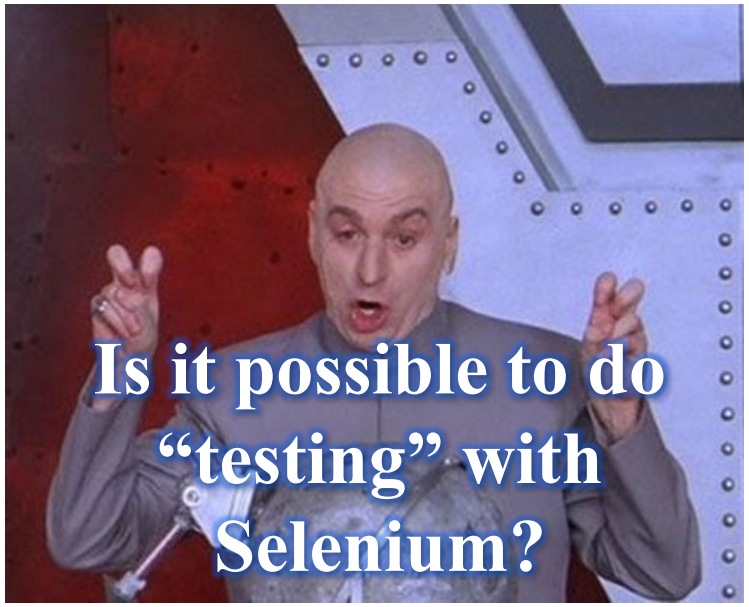
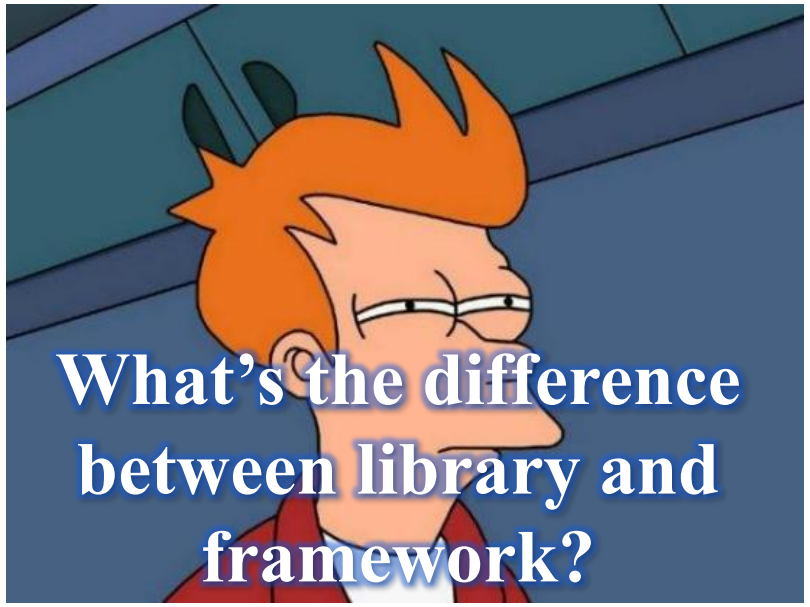
Selenium – What is NOT Selenium?

- Selenium is NOT a testing framework 
- Selenium is NOT a testing library 





Library vs. Framework

- A **library** is a collection of code that developers can call using an API to solve a given problem

- A **framework** is a library that that provides a foundational structure for developing software applications

Summary

	Selenium	Cypress	Puppeteer	Playwright
Nature	Browser automation library	End-to-end testing framework	Browser automation library	End-to-end testing framework
Automation mechanism	Web standards (W3C WebDriver)	Custom architecture based on JavaScript	Chrome DevTools Protocol (CDP)	Patched versions of some browsers
Languages	Java, JavaScript, Python, .Net, Ruby	JavaScript	JavaScript or TypeScript	JavaScript, TypeScript, Python, .NET, and Java
Browsers	All major browsers	Chromium-based browsers, Firefox, and WebKit (experimental)	Chromium-based browsers and Firefox (experimental)	Chromium, Firefox, and WebKit
Maintained by	The Selenium project	The Cypress company	Google	Microsoft